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DISTRIBUTION OF RESEARCH EFFORT IN BRITAIN

FIVE years ago, the Federation of British Industries published a statistical survey of scientific and technical research in British industry, based on an inquiry conducted during 1945–46 by its Industrial Research Committee. That survey was of particular interest as providing a forecast of the demands of British industry for research workers and technologists. Since then, we have had the reports from sub-committees of the Technical Personnel Committee of the Ministry of Labour and National Service, and a comprehensive report on chemical industry from the Association of British Chemical Manufacturers, as well as relevant reports from 'productivity teams', such as that on industry and the universities, of the Anglo-American Council on Productivity, and a report on scientific man-power from the Advisory Council on Scientific Policy.

The second survey of the Industrial Research Committee of the Federation, based on the year ended on or before March 31, 1951, which has now been published*, is thus of interest, less in relation to the man-power situation than from the point of view of the balance of the national research effort in general, and particularly in relation to development and industrial efficiency and productivity, on which such stress has been laid since the first survey appeared. Although a further five hundred copies of the questionnaire were circulated to industrial firms, a much smaller proportion of replies was received; and the 301 replies which were sufficiently detailed for analysis obviously represent too small a sample for sound or really authoritative deductions. These 301 firms were spending during 1950–51 the sum of £23,779,000 on research and development. If they are as representative a sample as the 420 firms of the earlier survey, the expenditure of which was £21,815,000, it might be inferred that expenditure has increased by about 50 per cent. On the other hand, an analysis of the expenditure of 107 firms common to both surveys suggests an increase of 100 per cent, and allowing for the difficulties in making an accurate estimate, the increase over 1946, on an expenditure basis, is probably somewhere between 50 and 100 per cent. On the assumption that the latest survey is as representative as the first, the total annual expenditure by industry on research and development within its own establishments could be put as between £45 millions and £60 millions.

This cannot, however, be assumed to represent a proportionate increase in research effort. Inflation in the past five years has reduced the value of the pound by a fifth, and the cost of equipment and salary-levels have both increased. From the point of view of research effort, this expenditure should be assessed first against corresponding expenditure in other fields, and secondly, against the numbers of qualified staff employed in research and development.

* Research and Development in the British Industry: a Survey of Expenditure on Industrial Research and Development in the Year 1950–51 made by the F.B.I. Industrial Research Committee. Pp. 19. (London: Federation of British Industries, 1952.) 1s. 3d.

On the first criterion, it should be noted that the survey excluded firms which reported a research and development expenditure of less than £2,000 per annum. The smaller firms, however, still represent the bulk of the industrial units of Great Britain : less than one per cent of our industrial units employ more than 500 people each ; some 92 per cent employ less than 50, and it is these smaller firms that constitute the major problem in securing the more widespread and effective utilization of scientific knowledge in production. To some extent their research needs are met by the research associations, which like the nationalized industries are excluded from the survey. The expenditure of the forty-two research associations during 1950–51 was £3·4 millions, of which £2·15 millions was contributed by industry, as against £1 million by the twenty-six research associations of 1945–46, in which was included £570,000 from industry.

It is not easy to get a clear picture of the distribution of the research effort of Great Britain as between industry, government establishments and the universities. In the House of Lords debate on June 11, the Lord President of the Council put State expenditure on civil research at £16 millions a year, apart from that included in the £18 millions provided for the universities. Besides £5·5 millions on the Department of Scientific and Industrial Research and the research associations, this £16 millions includes £1·5 millions on medical research and £3 millions on agricultural research ; and in the same debate Lord Waverley put the total expenditure on industrial research in the great firms and in the Department of Scientific and Industrial Research at not less than £50 millions a year. Excluding research on nuclear physics, current expenditure on fundamental research in the United Kingdom was put by the 'productivity team' on the universities and industry at not more than £1·5 millions, compared with some £30 millions expended in the same way in the United States.

These estimates are presumably based in part on the £141 millions for research and development in the Civil Estimates for 1951–52 ; for 1952–53 the corresponding figure is £161,433,349. But it is difficult to obtain an adequate breakdown of this figure or of the £650 millions for production and research in the defence estimates for 1952–53 (an increase of £250 millions on 1951–52). The 1952–53 Civil Estimates includes the sum of £13,893,500 on research and development in the Navy estimates and £1,350,000 for Colonial Development and Welfare Research Schemes, but not that part of the £25 millions for universities and colleges which goes on research. It includes nearly £2 millions for the Medical Research Council, £1 million for the Agricultural Research Council and a further £1·9 millions for research and development work under the Ministry of Agriculture and Fisheries, as well as some £650,000 for the Department of Agriculture for Scotland. Just over £1 million goes to the Ministry of Works. The major item, however, is £128,308,000 for the Ministry of Supply—an increase of £18 millions on the corresponding vote last year. Of this, £52,750,000 is for research and development work carried out by industry or extra-mural work by the universities, while £7,896,380 is accounted for by the civilian staff of the Research and Development Division and £483,484 by that of the Directorate of Scientific Research and Technical Division.

Although details of the staff employed in the various directorates and divisions of this Ministry are included in the Civil Estimates, it is not easy to gain a clear picture of the research effort for which it is responsible in terms either of money or staff. Its complicated character is apparent from what has already been said, and in his highly critical comment on June 12 Lord Falmouth stated that the Ministry employed a staff of 1,051 scientific officers, 1,001 assistant scientific officers and 1,444 technical assistants. The civilian staff of its Research and Development Division alone numbers 14,449, with a further 2,300 in the Directorates of Atomic Energy, of Guided Weapons and Electronics, of Scientific Research and Technical Development, the Chief Scientist and the Chemical Inspectorate.

With all allowance for the value to industry of work done in this Department, the government staffs employed on research and development in this way look considerable when placed alongside the 3,700 employed by the Department of Scientific and Industrial Research, or even the 31,000 persons estimated by the Federation of British Industries as engaged full time by the 301 firms on research and development work. Of these, about 8,500 possess a university degree or equivalent qualification. But the survey attempts no estimate of the number of persons employed full-time in industry as a whole on research and development. The earlier survey put this at roughly 45,000, of whom about 10,000 were qualified scientific men or technologists. An analysis of the qualified staff of some 254 firms as at 1946 and 1950 indicates an increase of about 50 per cent, and while there is evidence of a slight general increase in the ratio of unqualified to qualified staff, it would appear from this survey that the number of qualified scientific men and technologists employed by industry on research and development is unlikely to exceed 15,000 in a staff of perhaps 65,000 to 70,000.

Among this qualified staff, chemists are still the most numerous ; but their 38 per cent is now followed closely by engineers (35 per cent), physicists coming third with 11 per cent, compared with 44, 33 and 10 per cent, respectively, in 1946. In these 254 firms the number of chemists employed increased from 2,357 to 2,945, of engineers from 1,455 to 2,655 and of physicists from 844 to 2,357. The number of biologists was 182 in place of 92, of mathematicians 115 compared with 61, and metallurgists 416 in place of 293. Expenditure per unit of qualified staff varied from a little more than £2,000 in heavy electrical engineering to more than £4,000 for glass and for textiles, compared with £1,600 to £2,300 in 1946. The ratio of unqualified to qualified staff also fluctuates considerably, varying from about 2 in glass and in the scientific instruments and heavy electrical engineering groups to 5·2 in light electrical engineering, but generally shows a slight upward trend.

The total floor space of the research and development departments of 249 firms has increased by 54 per cent since 1946 and is approximately 1,000 sq. ft. per qualified member of staff. Research and development expenditure expressed as a percentage of turnover varied considerably in the industrial groups analysed, being as little as a half per cent in textiles, the ferrous metals, and the food, drink and tobacco group, and as much as five per cent for light electrical engineering and scientific instruments. The figure of 2·4 per cent for the chemicals group compares with that of 3 per cent for Imperial Chemical Industries, Ltd., in 1950 given by Sir Wallace Akers to the International Symposium on the Organization of Scientific and Industrial Research.

On the evidence of this survey, the research and development effort of British industry is unlikely to have increased by more than 50 per cent since 1946, and the upper estimate of about £60 millions contrasts with Dr. Vagtborg's estimate of an expenditure on research of 600 million dollars by American industry, or 2,000 million dollars if development work is included; Lord Hall, in the debate on June 11, quoted a figure for 1951 of £900 millions. This comparison, moreover, ignores the question whether the research effort is wisely directed at the right targets, and whether the best use is made of technological and scientific man-power, so that it is not wasted on tasks that could be equally well performed by clerical, administrative or less highly trained technical staff.

Such questions, however, are all-important in considering the distribution of the research effort of Britain, and particularly the proportion that is carried out directly or indirectly under the auspices of the State, a point Lord Falmouth was inclined to overlook in his criticism of the Ministry of Supply. By and large, however, the expansion of research and development in British industry lags behind that of other countries, and as Sir Henry Tizard maintained in his Messel Memorial Lecture at Aberdeen on July 9, its dependence on the State is increasing.

The survey made by the Federation of British Industries is purely factual: no attempt is made to discover or discuss the causes of the trends revealed. It is the more useful, therefore, to examine the survey in the light of some of the replies received to questionnaires sent out by the Parliamentary and Scientific Committee to various affiliated scientific institutions and research organizations, as well as to the directors of research of some major industrial firms, in connexion with the debate in the House of Lords on June 11 and 12. A number of the replies confirmed the view expressed in that debate and elsewhere that the lack of a sufficient number of trained scientific men and technologists, particularly on boards of directors, is an important factor in delaying the application of research results in industry. This deficiency is being gradually remedied, and the discussions on higher technological education have focused a fair amount of attention on it; though in this connexion and particularly while the shortage of certain categories of scientific men persists, more attention could well be given to the most effective use of the time of such men. The ratios of qualified to non-qualified staff quoted in the Federation of British Industries survey appear to justify one comment by the Parliamentary and Scientific Committee that more use could be made of less highly qualified staff on duties which do not really demand the expert knowledge, for example, of a trained chemist.

Much emphasis was laid in the replies to the Parliamentary and Scientific Committee's inquiry on the obstacles to development presented by the present fiscal policy in regard to plant obsolescence, and by the long delays experienced in obtaining delivery of plant or equipment, licences for plant extensions and other capital projects, as well as to the danger that rapidly mounting costs of re-equipment and plant alteration are tending to involve capital expenditure beyond the resources of a small company. Such factors, which are a direct result of Government policy, tend to overshadow the conservatism of the British manufacturer and consumer. Sir Henry Tizard was right to appeal for a greater spirit of adventure on the part of industry; but British industry will also be grateful for his outspoken reference to the way in which taxation policy discourages industrial adventure. The point is one which the Parliamentary and Scientific Committee might take up strongly.

Apart from the shortage of qualified scientific men and technologists, particularly of engineers, chemists, physicists, metallurgists, chemical engineers and physical chemists, replies to the Parliamentary and Scientific Committee's inquiry suggested that the rapid application of scientific knowledge in industry is being hindered not only by the absence of sufficient numbers of those able to assimilate and apply such knowledge, but also to some extent by defective means of dissemination. Both presentation and interpretation require improvement, and Sir Wallace Akers, who in commenting on the staff position had stressed the importance of quality rather than quantity, and the serious effect on the teaching of science in schools of the scarcity of really good scientific staff, urged Government assistance in the publication of original scientific papers and abstract journals.

Generally speaking, the replies to the Parliamentary and Scientific Committee's inquiry contributed little that is new, and the general trend of opinion was faithfully reflected in the House of Lords debate. Strong support was forthcoming for more generous support for the research associations and the government research stations, and there was no suggestion that the distribution of research effort as between industry, government establishments and the universities is unbalanced; nor was concern expressed that there is excessive reliance upon the State. Sir Wallace Akers, indeed, referred to a suggestion that the Department of Scientific and Industrial Research's grant system should be extended to encourage the appointment of effective field-teams, particularly in those research associations serving industries which are not remarkable for their technical progress. He also commended a suggestion that the research associations might be used as recruiting agencies for

the corresponding industries by establishing training schools within the associations themselves to provide courses for production and research staff for these industries.

The educational potentialities of the research associations deserve more attention than they have yet received, both in regard to the expansion of technological education and from the point of view of industrial recruitment and the movement or interchange of staff both with industries and with the colleges of technology or even the universities. This is a further reason for viewing with concern the recruiting difficulties to which the Advisory Council for Scientific and Industrial Research directs attention in its recent report, and for probing further the reasons for the reluctance of many of the best science graduates to enter the government scientific service.

That, of course, is independent of the question whether or not, in fact, an undue proportion of the nation's scientific effort is being made under government auspices. The question of quality, however, scarcely enters into the strictly factual survey of research conducted by the Industrial Research Committee of the Federation of British Industries, though it was clearly in the minds of some at least of those who replied to the questions of the Parliamentary and Scientific Committee. None the less, the survey, like the memorandum of the Parliamentary and Scientific Committee, gives a picture of the present position and an indication of some of the trends and the close relation of industrial research and development to such matters as technical and technological education and the effective dissemination of the results of research, in which circumstances to-day have increasingly thrown large responsibilities on the government. The observations and suggestions will no doubt be carefully considered by Lord Woolton and by Lord Cherwell on behalf of the Government, and it is to be hoped that they will bring the necessary note of urgency to the formulation and execution of an adequate policy, both in regard to industrial research and development and such ancillary matters as technological education.

SCIENCE AND SOCIETY

The Impact of Science on Society

By Bertrand Russell. Pp. 140. (London: George Allen and Unwin, Ltd., 1952.) 7*s*. 6*d*. net.

THIS book, which appeared appropriately as Lord Russell celebrated his eightieth birthday, has more unity than might be expected from the prefatory statement that it is based upon lectures originally given at Ruskin College, Oxford, and that the last chapter, which discusses the stability of a scientific society, was given as the Lloyd Roberts Lecture at the Royal Society of Medicine, London, on November 29, 1949. For some readers the book's main interest may derive from its revelation of Russell himself, but it is something more than the musings or reflexions of one of the most brilliant intellects of our times. Here is no octogenarian living in the past. Once again the gifts that have stimulated two generations play over the problems that scientific advance in the last three centuries have created for mankind—the clash between science and tradition, the general and the specific effects of scientific technique in an oligarchy or totalitarian regime and in a democracy, the relations of science and war and of science and values, and the stability of a scientific society, whether dictatorship or democracy. If he is sometimes more subtle than in some earlier books and the gentleness of age leaves it for the reflective reader to discover how penetrating and stimulating some of his comments and observations really are, we have still in good measure the impish, almost Puck-like wit that we have long been accustomed to from one whose intellectual eminence is linked with the freshness of youth.

Save where in his first chapter he touches on science and tradition and stresses three factors in the scientific outlook of the eighteenth century that were specially important in developing the mechanistic outlook, and again when he discusses the philosophy of human power, the philosophical element in this book is slender. This, however, is what gives the book its distinctiveness, as may well be seen if it is set beside the study, similarly entitled, and of like length, to which fifteen years ago Lord Stamp expanded his presidential address to the British Association. On the general effects of scientific technique on society, the problems of science and war and even the question of science and values, both Russell and Stamp have much to say that is similar. Both were convinced that one of the main consequences of scientific development is to increase the interdependence of peoples, and that science offers possibilities of far greater well-being for the human race subject to the fulfilment of certain conditions. Even on those conditions they would seem to be broadly in agreement. As defined by Russell these are: the abolition of war; even distribution of ultimate power; and limitation of the growth of population. Stamp was largely concerned with the devising of practical measures to prevent the stresses arising from social or industrial disequilibrium due to excessive rate of change, and his agreement with the second condition is implicit rather than explicit. On the first and third, Russell is no more emphatic than Stamp, for all the experience of the intervening years, which has shown the necessity for finding some means of averting recourse to war and of limiting the growth of population if the world is to avoid either destruction of civilization or starvation.

The difference in emphasis and in outlook between the two studies lies in the quickened appreciation of the importance of the problem of power which marks that of Lord Russell. Not all the aspects of the problem are indeed illuminated by him: at some of the darker problems, such as that of the control of mind and personality, Russell only hints. He is concerned above all with the problem of officialdom in the scientific society which may confront us, and if to the question how the government itself is to be controlled by the governed he gives no clear answer, much in his book should stimulate the scientist to deep thought, whether he is concerned primarily with the future of science or that of society.

When he touches on the practical problems of how world government is to be achieved, the growth of population controlled, or the abuse of power prevented so that freedom of initiative and expression are ensured in the new context, Lord Russell is disappointing. He closes, indeed, on a note of

optimism rather than pessimism; but he is hopeful rather than confident. His firm condemnation of the fanaticism of our times is not matched by the same assurance in giving his reasons for thinking that mankind may avoid the disaster which such fanaticism and refusal to adjust its activities in the light of reason threaten to bring. He discounts unduly the part played by emotions in human affairs, seems to regard emotion as necessarily or essentially evil, and to discard religion with the fanaticism he denounces. Perhaps for this reason—whereas Stamp, calling for an advance in the science of man commensurate with the advance in the science of matter during the past three centuries, leaves us facing the future with some confidence that we can regain control over events—Russell, declining to believe that the world war and world disaster are inevitable, for all the factors which he delineates as tending to bring them, leaves us wishing that wisdom and reason may prevail rather than with the serene confidence of those who have seen and believe in the greatness of man and who share in the appreciation of what is noble, beautiful, gentle and wise, and in the vision of a society, where individuals grow freely and where hate and greed and envy die, of which he spoke in his broadcast reflexions on his eightieth birthday. R. BRIGHTMAN

MOLECULAR SPECTRA AND MOLECULAR DYNAMICS

Molecular Spectra and Molecular Structure

I: Spectra of Diatomic Molecules. By Gerhard Herzberg. Second edition. Pp. xv+658. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 9.75 dollars; 73*s*. 6*d*. net.

FROM time to time a landmark appears along the hard road towards the complete understanding of molecular dynamics, serving not only to please and encourage, but also to stimulate us to further effort. Such is this book, a work of authority, of splendour and polish, and—in spite of its encyclopædic content—of absorbing interest. The first edition was published twelve years ago at the outset of the Second World War, and few copies were available outside the United States, so few indeed that my own copy was almost continuously on loan. This new volume is the most thorough treatment and reference work on the spectra of diatomic molecules yet published. It covers ground which is equally important in physics and chemistry, and in revising the book the author has added new sections on microwave spectra, Zeeman and Stark effects, hyperfine structure, and many aspects of photodissociation, as well as giving us some promising new data on astrophysical phenomena.

Dr. G. Herzberg's clarity as a lecturer is well known, and this is reflected in his books. He has assembled here all the salient theory of molecular dynamics required for the interpretation of rotational, vibrational and electronic band spectra, amply illustrated by numerical results and photographs, and directly applied to a variety of typical cases. All this is presented in a logical readable form. There is too often a tendency by some workers in this field to clothe the subject-matter in a shroud of forbidding mathematical formulation, which leaves the ordinary reader or the student both exhausted and in despair. Dr. Herzberg deals properly and adequately with such mathematical theory as is needed for the problems involved and, incidentally, provides a clear exposition of the wave-mechanical principles; he never fails, however, in illuminating asides, to seek some attractive physical picture or visualizable analogy, as, for example, his model to illustrate the meaning and mode of action of the Franck–Condon principle. The somewhat puzzling topics of vector coupling of momenta, of the symmetry properties of different energy-levels, and of ortho- and para-modifications are also clearly discussed, and all the ramifications of the rotational fine structure associated with electronic-vibrational transitions are set out.

The later parts of the book deal with the dissociation processes associated with different kinds of continuous and diffuse spectra, and with the electronic structure of molecules in relation to stability and interatomic forces. The derivation of molecular data such as heats of dissociation and potential energy diagrams is explained fully, and in a critical manner.

Finally, an up-to-date table is given of the energy-levels, vibrational frequencies, anharmonicity coefficients, rotational constants and other desirable data, which will long remain a place of reference for all those working in this field and for many others less directly concerned. More data are now becoming available about the higher vibrational levels of molecules in the electronic ground-state, studied with high-dispersion grating spectrometers and very long absorption paths, and the greater precision which is now possible may well lead to a revision of some of the molecular constants listed in this table. Yet this does not in the least detract from the enormous value of Herzberg's compilation. This is, in fact, an admirable book. H. W. THOMPSON

SUGAR BEET DISEASES IN IRELAND

Sugar Beet Diseases in Ireland

By Prof. Robert McKay. Pp. ix+78+37 plates. (Dublin: At the Sign of the Three Candles, 1952.) 21*s*.

TO his illustrated guides for the recognition and control of flax and tomato diseases Prof. Robert McKay now adds this third volume, and like its predecessors it is attractively produced, beautifully illustrated, and reveals first-hand knowledge of the subject. Sugar beet has been grown commercially in Ireland for a quarter of a century, and the crop is subject there to much the same diseases as occur in England, though not always in the same degree. Black leg, for example, causes considerable loss every year and is not controlled by seed treatment with organo-mercury dusts, whereas in England, where seed treatment is a routine operation, this disease, though common, is rarely destructive.

The very heavy loss in sugar yield (about £6,000,000) experienced in England in 1949 as a result of the worst epidemic of virus yellows known there, has not been paralleled in Ireland, and both mosaic and downy mildew are evidently also of less significance. This may well be due in no small measure to the action of the Irish Sugar Company, which, following moderate epidemics of virus yellows and downy mildew in 1946, insisted on stecklings being grown in complete isolation from seed and root crops,

and on seed and root crops being grown in separate fields and as far apart as possible.

Until 1940, all supplies of mangold and beet seed had been imported into Ireland from the Continent; then it became necessary to produce home-grown seed, and for convenience the seed crop was raised in the same fields as the roots. As a result the major diseases increased rapidly during the next six years. No severe epidemics have occurred since compulsory isolation was introduced in 1947; but recent partial failures clearly indicate that it is not sufficient merely to raise stecklings in isolation. The steckling areas must be chosen carefully, and build-up of virus in them must be prevented by keeping down ground-keepers under a proper rotation.

Prof. McKay describes about two dozen diseases. His main conclusion is that their control is a matter of prevention rather than cure, of good husbandry rather than protective spraying. His story is an interesting one, and should be readily understood by anyone interested in sugar beet production. Ten of the thirty-seven plates are in colour; there is a glossary of the fifty or so technical terms used; and an author as well as a subject index.

W. C. Moore

TRANSCENDENTAL PHENOMENOLOGY

Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie

Von Edmund Husserl. Buch 1 (Husserliana, Band 3): Allgemeine Einfuhrung in die reine Phänomenologie. Neue, auf grund der Handschriftlichen Zusätze des verfassers erweiterte Auflage. Herausgegeben von Walter Biemel. Pp. xvi+483. 20 guilders. Buch 2 (Husserliana, Band 4): Phänomenologische Untersuchungen zur Konstitution. Herausgegeben von Marly Biemel. Pp. xx+426. 19 guilders. Buch 3 (Husserliana, Band 5): Die Phänomenologie und die Fundamente der Wissenschaften. Herausgegeben von Marly Biemel. Pp. vi+167. 6.75 guilders. (Haag: Martinus Nijhoff, 1950–52.)

WITH these three stately volumes, the scholars of the Husserl-Archiv at Louvain bring their immediate task to an end. It would, however, be incorrect to write "Husserliana concluded", because there is some reason to suppose that further material of outstanding consequence to philosophers is still being worked over, and that, ahead again, we may be presented one day with an authentic biography of the master himself. In a recent discussion with Husserl's daughter, I gained the impression that the treasure-house has not yet been exhausted, which only underlines the debt which all serious students of the subject owe to Prof. H. L. Van Breda and his colleagues for their long labour of love. The present editions are the work of Dr. Walter Biemel and of Marly Biemel, and between them account completely for Husserl's researches and their development during the period 1913–25. Much of importance is to be found in a series of supplements to the main text, embodying somewhat copious rescripts. It is clear that publishers and printers have given of their best.

The first book contains the complete theory of phenomenological reduction, including the derivate factor of pure consciousness and its essence-correlate. An attempt follows to obtain a clear-cut approach to the former, with its influence upon recent scientific trends. In the second book the relation of phenomenology to the physical sciences, psychology and æsthetics is discussed. Here, the establishment of suitable pre-conditions is recognized as the first essential, and permits a deepening of previous knowledge.

The purpose of the third book is to probe the 'idea' of philosophy, in the light of the possibility of developing a norm of absolute knowing. Cognition at this level is seen as the pre-condition for any system of metaphysics (and former philosophies, too), which are in principle capable of appearing as sciences. It may be remarked that, in this context, some concordat is to be expected with an extended *philosophia perennis*, a point brought out some years ago from another angle. This may, of course, prove to be but a minor matter; what is more significant is that, by reflecting upon the ontological basis of the sciences, Husserl is gradually leading up to the feasibility of science offering—and in the event accepting—fundamental criticism of itself, and that at its own level. A recent author, in discussing the "Theodicy" of Leibniz (1710), has given reasons for thinking that a re-birth of metaphysics will assuredly come about one day: that this should be said just now, coupled with the prophetic insight of phenomenology, raises hopes that metaphysics may yet assume the role of a progressive discipline, and thus qualify to be regarded as a necessary outcome—among others—of Husserl's "Ideen". It is only too manifest that this is not the part which metaphysics is traditionally credited with playing, if the history of thought is widely analysed. Sometimes, for example, we find it neatly sliced away from contact with all experimental techniques, and left to justify itself, if it can, as a convenient mental short-cut when observational work had become tedious, or mathematics too hard. At other times, when a most valuable time-saving science—witness the rise of chemistry, which by its own efforts reached an empirical summit, unscaled by physics for ages—is discovered and pressed home, nobody would dream that, in a sense, a species of metaphysics was being evolved without ontological regard.

These are not exactly questions which can be settled by yea or nay; what matters is that a philosophical climate should be provided, such that, in it, they may be recognized as specific problems, even if insoluble for the general case. The structure underlying the doctrines of the present volumes is one at least capable, in theory, of embracing these situations.

Of these three contributions, therefore, it may be said that they represent the fullest development of Husserl's transcendental phenomenology, and that in a form embodying the most polished finish of which his system is capable. But there must be a tool, or *Methodik*, especially one deliberately fashioned to cut through to a philosophy which can lay claim to be prior to all (other) knowledge and scientific ratiocination. This weapon, the general character of which has been sketched on previous occasions, is the principle of phenomenological reduction. Its purpose is to attain to a pre-suppositionless region, with its emphasis upon pure consciousness (the individual ego), and in such a way as to be free from pre-judgment. The residue, after reduction, is the 'stuff', so to speak, of phenomenology, and the factor upon which it operates. A crude image of what this means would be the suspense account with which we

are more or less familiar in administrative affairs. Herein something is laid by for the time being, and no judgments passed upon it; for Husserl this comprises the world, and all 'posited' things. The German *ausgeschaltet*, often translated 'eliminated', does not wholly satisfy British minds; it inclines too heavily towards finality. To borrow an expression from electrical engineering, 'switched-out' is probably nearer the true connotation. There is then nothing to prevent us from throwing in the 'breaker' again whenever circumstances permit.

In bringing to a close this series of essays on Husserl's phenomenology which have appeared in *Nature*[1], it may be legitimate to take a final glance at the panorama spread out before us, now that the labours of the archivists have been so well implemented. Husserl was convinced to the end that his researches had indeed disclosed the existence of a *schema* of thought, free from vestiges of presupposition, and endowed with perfect rigour. If impact upon the world of learning is any criterion of truth, then, as the original memorial volume to the master's memory illustrated, his influence is already great. More particularly is this so in the *Geisteswissenschaften* (psychology, psychiatry and so forth), which are the most difficult to discipline, just because they are youthful and full of promise. There perhaps, more than anywhere else, is the value of suspense of judgment (reduction) most in evidence. The relative merits—or limitations—of *Gestalten* and association are still not fully resolved: as one example among many.

Finally, this may be the place to record the death of Prof. Husserl's widow, on November 21, 1950, at the age of ninety. It seems almost incredible that when she was nearly eighty she contrived to get her husband's papers out of Germany, and into the generous care of the authorities at Louvain. Surely, that feat alone is her fitting memorial.

And now the little band of scholars, some dozen years after the event, can lift up their eyes and look upon the fields, for they are white already to harvest.

F. I. G. RAWLINS

[1] *Nature*, **154**, 504 (1944); **156**, 516 (1945); **166**, 919 (1950).

A PROSPECT FOR ESTATE WOODLANDS

Estate Forestry

By Sir William Ling Taylor. Pp. xi+200+12 plates. (London: Crosby Lockwood and Son, Ltd., 1951.) 15*s*. net.

SIR WILLIAM TAYLOR, who was for many years a member of the Forestry Commission of Great Britain, ultimately becoming director-general, addresses this book to "the owners, agents and foresters who are concerned with the management of private estate woods". As this is one of the few books of any size to be published about estate forestry since the Second World War, it will certainly provide food for thought among those to whom it is addressed.

It comprises twenty-two chapters, of which the first three deal with forestry in general: its background, its problems and its national aspects. The next five chapters are concerned with sylvicultural problems and notes on broad-leaved and coniferous species. These are followed by five chapters on nurseries, planting, tending and maintenance, and coppice. After this, two chapters on damage and protection are included, and four chapters on the business side of forestry, including marketing, taxation, co-operative groups, with a chapter entitled "Forestry and the Farm". The last two chapters deal with the forest year and forestry books.

It is a very good thing to see that a chapter on the farmer's trees has been included, for in the past too little importance has been attached to farms as potential sources of timber. Since 1940 hedgerow trees have made a very useful contribution towards the timber needs of Britain. If it were only possible to persuade farmers that trees are worthy of better treatment than as fence posts, it would indeed be a step forward.

The question as to whether forestry pays or not is a problem which must be present in the minds of many who are concerned with woodland management at the present time. In answering this question, however, it is to be regretted that the author did not provide figures relating to the actual cost of the usual forest operations. Forestry is a business and, as in all businesses which are to remain solvent, one must know what the costs of production are.

The views which the author expresses on some points will not be accepted without question by some of his readers. His statement that "workers new to the woods, if well supervised, speedily acquire skill and soon become able to notch-plant up to a thousand transplants in a day's work" needs some qualification.

On the subject of the best tool to use for pruning, he says "there is little doubt that the best work is done with a sharp well-set hand pruning saw used in conjunction with a light ladder". This may be the experience of the author, but those who have seen the excellent results obtained with such chisel pruners as the 'Whitmore Pruner' may feel that Sir William is somewhat dogmatic.

The book is well produced and has a number of very good photographs, together with a synopsis of the Forestry Act, 1951, included as an appendix.

N. D. G. JAMES

STUDY OF THE WOOD RAT

The Dusky-footed Wood Rat

A Record of Observations made on the Hastings Natural History Reservation. By Jean M. Linsdale and Lloyd P. Tevis, Jr. Pp. x+664. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 56*s*. 6*d*. net.

THE dusky-footed wood rat (*Neotoma fuscipes* Baird.) is a medium-sized rodent native to North America. It and other species of the genus *Neotoma* are also called pack rats, trade rats, brush rats and cave rats. It rarely leaves its normal living-quarters in the wilds, though it sometimes comes to isolated habitations of man. Wood rats are nocturnal and are seldom seen without special search, but the conspicuous houses in which they live, built of sticks above ground, readily show their presence. The subspecies dealt with in this book is *N. f. luciana* Hooper of coastal central California.

The authors have investigated all the aspects of the biology and ecology of this animal for ten years on the Hastings Natural History Reservation in Monterey County, California. They have made an intensive study of this comparatively small area and

of the individual rats that lived there during successive generations. Their trapping methods made possible the repeated handling and examination of the rats, which were often kept under observation for the whole of their life-spans.

The population studied was more stable than that of most rodents, the stability reflecting a continuous and precise adjustment to the brushland and woodland where the animals live. A wood rat's ability to survive is affected by the conditions that enable it to leave its home and those that affect it away from shelter. A rat that lives in a house providing protection from the weather and predators is exposed to these dangers when away from home. It leaves its house mainly to get food and housebuilding material, to escape from dangerous intruders or intolerant members of its own family, and to find other rats.

Many rats contribute to the maintenance of few houses, which last much longer than any single occupant, but the character of each house is dictated by its situation and the available materials; it remains constant in type through successive tenancies. After a period of vacancy a house falls to pieces because it loses its 'sign', such as odour, deposits of fæces and urine, and gnawings; it is then no longer recognized by the rats as a house.

The wood rat is polycestrous, and breeding occurs throughout the year although there is a peak in early summer. The number of young in a litter averages about two, and females produce from one to five litters a season; the survival-rate is low, nearly half the litters of 1946 disappearing before any members of them were trapped. An important character of the population, however, is that the number of adults remains fairly constant. Every month sufficient new rats appear to replace the old ones that vanish. There must always be some homeless rats seeking suitable houses, probably young ones that have never had homes of their own and old ones driven out by aggressive newcomers. A rat driven from a bad house by weather or other factors may be able to oust the owner of a better one.

These are but samples of the topics covered by this book, which deals with every facet of the life of the wood rat from the cradle to the grave. The researches recorded here are not only an important contribution to the study of mammals, but also a most interesting and intimate account of the life of a charming creature. Few species of wild mammal have been so closely studied or so thoroughly portrayed.

L. Harrison Matthews

MENTAL EPIDEMIOLOGY

On the Objective Study of Crowd Behaviour

By Dr. L. S. Penrose. Pp. vi+74. (London: H. K. Lewis and Co., Ltd., 1952.) 10*s*. net.

THE study of crowd behaviour has long been hampered by the lack of suitable quantitative methods of treating the data. The analytical approach of writers like le Bon and Freud, profound and illuminating as it has often proved to be, is not enough to establish a systematic science of social behaviour. Prof. L. S. Penrose's monograph represents an important advance towards this goal. His contribution to methodology is twofold: first, in suggesting new techniques of measuring the effects of the size of a group on changes of opinion among its members; and second, in quantifying the conception of a 'mental epidemic'. Let us consider these briefly in turn. Prof. Penrose takes as his fundamental unit of measurement "a person characterised by possessing a given idea or potential reaction pattern". He makes the assumption that, in the type of group he is considering, the making of decisions and changes of opinion among the group members may be looked upon as random fluctuations which are a function only of group size. A comparatively small minority of members who know their own minds can then control the decisions of the indifferent majority. In general, the power of a bloc vote diminishes only as the square root of the number of indifferent members. The degree of control which a bloc of 5 exercises over an indifferent 25 is the same as that exercised by a bloc of 100 over 10,000. Given the size of the resolute minority and of the indifferent majority, an index of the power of the minority can be obtained by reference to tables of the normal curve.

Prof. Penrose's second main contribution also involves the same fundamental unit of measurement and is based on an analogy he draws between physical and mental epidemiology, the growth and decline of ideas in populations being described in terms of epidemics and immunity. Corresponding to the three factors distinguished by Stallybrass in physical epidemiology—namely, the infective agent, the means of transmission, and the susceptibility of the exposed population—so also in mental epidemiology there are: the quality of the idea; the visual, auditory and other means of transmission; and the mental state of the recipient. Apart from the analogy with single epidemics, analogies may also be drawn with periodic epidemics and with persistent diseases. This notion of mental epidemic is illustrated by reference to phenomena of crazes, panic, religious outbreaks, politics, war and the general transmission of ideas in populations. Two examples are provided of quantitative representation: one, a craze in medical treatment; and the other, voting in the American presidential elections over the period of a century. The various ways in which the above factors may be influenced is discussed, in particular by isolation, which heightens receptivity to ideas, especially ideas of suspicion. Isolation and suspicion thus produce a vicious circle.

Prof. Penrose does not, however, glorify statistical analysis at the expense of clinical and experimental methods. Nor does he regard an epidemiological model as the only useful one. He makes a number of enlightening remarks on the psychopathology of crowds. For example, he points out that, just as the individual mental patient is often unaware of his sickness, so a crowd may be unaware of disturbance in its behaviour, and "the recognition of the pathological nature of many aspects of crowd behaviour may prove a stabilizing factor in the development of human cooperation".

It should perhaps be mentioned that the book deals primarily with phenomena of collective behaviour, not with those phenomena of mutual interaction in groups which are increasingly occupying the attention of experimental workers in social psychology.

Prof. Penrose's suggestions are at once original and ingenious. They can be readily applied to experimental as well as to historical data, and they may have an important bearing on such questions as the best size of national representation in a world assembly.

John Cohen

Stereoptics

An Introduction. By Leslie P. Dudley. Pp. 112. (London: MacDonald and Co. (Publishers), Ltd., 1951.) 15*s*. net.

THIS is a fascinating little book which should prove excellent relaxation for the physicist specializing in other fields and a good introduction for the serious student of the subject of stereoptics. The author, who is the originator of the apt term 'stereoptics' to describe the theory and applications of stereoscopic principles, particularly in the field of photographic optics, is also the technical director of Stereoptics, Ltd., London, and has played a large part in Great Britain in developing new processes of stereoscopy.

The book is chiefly concerned with the application of stereoptics to photography, cinematography and radiography, the first part dealing with general principles and processes which require some form of viewing device in order to perceive the stereoscopic effect, and the second part with a discussion of some of the more important auto-stereoscopic processes. An auto-stereoscopic photograph is one which exhibits a three-dimensional or solid effect without the use of a viewing device by the observer. Such photographs are now familiar objects, but it is good to be reminded that it was in 1902 that Frederic Ives filed his classic patent application for the first practical method, probably based on a suggestion of Berthier's, in 1896, of producing an auto-stereoscopic photograph. The various parallax stereogram and panoramagram processes and developments which have since been patented and used successfully are clearly described in an attractive and interesting, though technical, manner.

The author's own important contributions are modestly mentioned. The final chapter in the book deals with stereoscopic radiography, the use of which offers great potential advantages both industrially and medically. In this field the author can claim to be an authority, and his enthusiasm and optimism about the rapid advance and promising future of three-dimensional pictorial presentation should win over even the most sceptical of readers.

S. WEINTROUB

British Journal of Applied Physics

Editor: Dr. H. R. Lang. Vol. 2 and Supplement No. 1, 1951. Pp. v+370+viii+96+vi. (London: Institute of Physics, 1951.)

THE decision of the Institute of Physics in 1949 to commence a separate monthly periodical, the *British Journal of Applied Physics*, in addition to its *Journal of Scientific Instruments*, has been more than amply justified judging by the excellence of the contributions received and by the welcome given to the new *Journal* by physicists generally and more particularly by those employed in industry. In Vol. 2 the high standard set by the preceding volume is, if anything, surpassed.

In addition to the twelve monthly issues, containing special articles, conference reports and original contributions, the volume includes a supplement of some ninety pages on the physics of lubrication, in which the proceedings of the conference on that subject held in Manchester by the Institute and the British Society of Rheology during 1950 are reprinted. Four other conferences—on the aspects of fluid flow, spectroscopy, the development and application of Fourier methods in crystal-structure analysis, and the texture and structure of metals—form the subjects of special reports. Three of the nine special articles will be of particular interest to teachers of physics in technical institutions: these deal with the rationalized M.K.S. system of units, procedure in industrial physics and its implications for education, and impressions of a discussion on technical universities. The numerous original contributions, on the average four per issue, cover a very wide field, but nearly all have direct applications in industry.

The editor and advisory committee are to be congratulated for maintaining in these difficult times such a high standard, both as regards content and production.

Science and the Christian Man

By Charles E. Raven. Pp. 60. (London: S. C. M. Press, Ltd., 1952.) 4*s*. 6*d*. net.

THIS book consists of six broadcasts delivered by Canon C. E. Raven. It suffers from the unavoidable defects of all broadcasts—the covering of too much ground with too few words, of using insufficiently established premises and of leaving a multitude of loose ends. Such a book should be regarded as a provoker of thought rather than an authoritative manual. All will agree with the author that the Christian man cannot say no to science, which is a great achievement of the human spirit, and from which the man of to-day can scarcely stand aside: but the treatment of the relation of science to the beliefs of the Christian is less satisfactory. Canon Raven dismisses almost all the miraculous element in the Christian evidences, and indeed seems to select for credence only such passages from the Scriptures as suit his views; modern churchmen who think as he does will doubtless find the book much to their minds. On the other hand, Roman Catholics take a more stringent view of the interpretation of the Scriptures in a fashion other than literal; consequently Canon Raven's book will, for them, miss the point. This said, the book is to be commended. Many things are finely said, and few will read it without discovering in it some new facet of the great problem it discusses.

F. SHERWOOD TAYLOR

The Southern Marches

By H. J. Massingham. (Regional Books Series.) Pp. xv+368+25 plates. (London: Robert Hale, Ltd., 1952.) 21*s*. net.

THE Southern Marches—the southern borderland between England and Wales—comprises the region between the Wye and the Usk, between the Bristol Channel and north Herefordshire. Apart from places like Monmouth, Tintern, Chepstow, Symonds Yat, Ross, Raglan and the Channel of the Lower Wye, these southern marches are little known. In this book the late Mr. H. J. Massingham set out to bridge this gap in knowledge, and he succeeded very worthily. The ground is surveyed not only topographically but also in such aspects of the region as its architecture, its agriculture and its atmosphere. Local 'worthies' are given generous attention, while issues arising out of the author's travels are freely ventilated. Occasionally Mr. Massingham's views, like his prose, are extravagant, but these merely serve to accentuate the virility of a book which those who know and love the Southern Marches will treasure for years to come. "The landscape between Tintern and Chepstow" will indeed "continue to operate as tho' Paradise had never been lost". T. H. H.

CHAUCER'S ASTRONOMY

By Dr. DEREK J. PRICE
Christ's College, Cambridge

A FOURTEENTH-century astronomical manuscript in Peterhouse, Cambridge, was recently put forward* as a holograph draft of an unknown work by Geoffrey Chaucer. The tentative case has now been considerably strengthened by a photographic comparison of the handwriting with that of another suspected holograph in the Public Record Office. The similarity is striking in spite of a gap of seventeen years between the two specimens, and, taken with the linguistic and circumstantial evidence, it poses a problem which it is difficult, if not impossible, to answer without accepting Chaucer as the author of this "Equatorie of the Planetis".

A certain amount of interest in the text arises from its providing a new example of Chaucer's prose, for the first time unsullied by scribal perversion, and there is also the sentimental regard that one must have for a work in the poet's own hand. Two other aspects demand attention from the historian of science: What light is shed on Chaucer as a scientific writer, and what light is shed on medieval astronomy?

Chaucer's writings supply all the information we have about his interest and participation in scientific activity, and any comparative study is hindered by the fact that the interesting astronomical literature in Middle English has not been accorded the scholarly attention given to the Latin writings. From the frequent astronomical allusion in the "Canterbury Tales" and in his other works, it is clear that Chaucer was very well grounded in the "Almagest" of Ptolemy, and was competent as an observer and calculator. More certain evidence is provided by his "Treatise on the Astrolabe", written in 1392, and still to-day the best work in the English language on this extremely important medieval instrument which served both for observation and as an ingenious calculator for determining the positions of the stars at any time.

It is apparent that for astrologer and astronomer there is a complementary problem of finding the positions of the planets at the same time, and indeed in the Prologue of the "Astrolabe" we are told that such a section is to be included. The extant manuscripts, however, give only slightly more than two of the promised five portions, and we therefore possess only the sections on the astrolabe itself, with a little additional matter.

The new "Equatorie of the Planetis" together with its accompanying sets of astronomical tables go far to providing these missing sections. It seems as if Chaucer first wrote his table of contents and then modified his plan as the work proceeded—a technique that is also to be found in the "Canterbury Tales". As with the "Astrolabe", he was working from a Latin translation of an Arabic original, and if we are to judge by the frequent errors and corrections, and the large sections which have been struck out as erroneous, it must be admitted that an increase in complexity towards the end of the text led finally to the abandonment of the matter. The writer adopts the same personal and repetitious (but pleasant) tone of elementary instruction as in the "Astrolabe", and it is not surprising that he should ultimately fail when describing the finer detail of a topic which held a position similar to that of the theory of relativity in the first quarter of our present century. We can only conjecture how much of the failure was due to impossibility of simplification, and how much to imperfect understanding—certain errors show that the latter factor was not altogether wanting. On the other hand, original observations and computations show that he was not just translating or plagiarizing from an already existing work, but attempting a bold and popular account of an instrument which he considered important. He speaks of his own instrument and comments on its being smaller than would be desirable.

On the whole we get the impression that, although Chaucer did not attain the standard of coeval professional astronomers, he was nevertheless thoroughly well-schooled and competent. Aided perhaps by personal contact, he must have been abreast of the tremendous intellectual activity of the astronomers at Merton College, Oxford, who had made England pre-eminent in that field of learning during part of the thirteenth and fourteenth centuries. The existence of this second major piece of scientific writing also causes us to wonder whether Chaucer may have spent more of his later years in treating other technical subjects in the vernacular.

The new manuscript volume commences with some long sets of tables and then proceeds to describe the construction and use of an instrument which employs these tables for determining the position of the planets in the zodiac at any given time. It does this by simulating the geometrical construction required by the Ptolemaic theory, with its system of eccentric deferent circles and epicycles. The several constants of each planetary orbit are marked, once and for all, on the 6-ft. diameter board and ring of the *equatorie*; then two angles, each of the form $\theta = \theta' + \omega t$, are laid off on the instrument, and the position of the planet may then be read on the graduated limb.

The ingenious character of this particular form of equatorium, as opposed to all other reported varieties, lies in making the centre of the instrument represent the point (Aryn) at the centre of the earth, while permitting one standard-sized circle to serve as the deferent of all the planets. The very existence of such an instrument serves as confirmation, if such be needed, that the professional astronomer regarded the Ptolemaic system as a mathematical model, and not as the arrangement of material crystalline spheres described in more popular tracts. The construction of a facsimile of Chaucer's instrument has shown that results may be read to an accuracy of about five minutes of arc, and to this order of fineness the Ptolemaic theory serves well. In spite of widespread belief to the contrary, the Ptolemaic and Copernican planetary theories are almost identical in their mathematical consequences, and must give similar results for latitudes and longitudes and changes in apparent brightness of the planets. Copernicus modified and improved the theories of the moon and Mercury and threw new light on the system as a

* *Times Lit. Supp.*, Feb. 29 and March 7, 1952.

whole by considering motion relative to the sun, but this does not bring any new principles or accuracy to his basic mathematical theory.

The astronomical tables used by Chaucer are based on that version of the "Alfonsine Tables" which was eventually published in Venice and Paris (first edition, Venice, 1483). At least three different forms of these tables are known, the present one being distinguished by the use of *signa physica* of 60° instead of the more usual *signa communia* of 30°. It is also noted for the tabulation of variables to ten sexagesimal places instead of the maximum of four or five places that are demanded by the accuracy of the observations on which they are based, and to which other versions of these tables are restricted. Such excessive zeal in computation could not have been of much use in the Middle Ages (it corresponds to an order of accuracy of about 1/1,000 sec. in 1,000,000 years), but it is invaluable now as providing unmistakable evidence for reconstructing the processes, approximations and assumptions used in the original calculations. One result of this analysis is to show that their 'bad' value of precession, one revolution in 49,000 years, does not refer to precession in the modern sense, but to the calender error introduced by the assumption that the (solar, tropical) year is exactly 365¼ days. This is, of course, the error that is now corrected by dropping three intercalary days in four hundred years, that is, 365¼ days or one revolution in 48,700 years. It accounts for just over half the true precession, the remainder being allowed for by making the sphere of fixed stars oscillate ± 9° with a period of 7,000 years, this being the 'trepidation' introduced by Thebit.

The form of these planetary tables is responsible for the invention and use of such equatoria as that described by Chaucer. The Ptolemaic theory is well adapted to the calculation and explanation of specific cases and limiting examples (such as the location and magnitude of retrogradation), but it is not at all convenient, even with the best tables then available, for the routine calculation of planetary positions—such as were required for horoscopes and for practical astronomy. One can, it is true, make very good approximations as Ptolemy himself did; but medieval scholars much preferred an exact solution. It would have been possible to draw up a complete calender of computed positions for, say, the next hundred years, but before the era of the printed book this was an expensive and wasteful procedure. Alternatively one could make use of the fact that after some appropriate period the anomalies of any one planet returned quite closely to a previous position, and this allowed the computation to be restricted to one such cycle only. Such sets of cycles forming "perpetual ephemerides" were calculated by Azarchiel in the eleventh century and continued in use until the cumulative errors of several cycles made them obviously invalid.

The only remaining possibility was to retain the full theory for exact calculation, but to substitute precise geometrical construction for intractable trigonometry. The earliest examples of such means (as distinct from ancient demonstration devices similar to the orrery) seem to be due to Azarchiel and Ibn al-Samh in the eleventh century. Going hand in hand with the re-making of tables, these works were translated by the Alfonsine *atelier* and adapted for use with the tables made during 1263–72. Thereafter it seems to happen frequently that a new set of tables, or a revision, is accompanied by a *Canon* describing some type of equatorium. We have accounts of instruments designed by John of Linières and by Profatius, and one is ascribed to John Campanus of Novarra (who was probably only the translator); there is also the "Albion" of Richard of Wallingford, which was improved by Simon Tunsted and elaborated by John of Gmunden. Contemporary with that of Chaucer is a similar but more complete instrument described by the Iranian al-Kāshī, and finally, in 1540, the series of instruments culminated in the publication of the sumptuous "Astronomicon Caesarum" of Peter Apian, who made the ultimate improvements of dispensing with the auxiliary tables and separating the various functions of the instrument so that it could be reduced to a set of paper volvelles bound into a book.

The "Equatorie of the Planetis" provides us with the only account in English of this device, and focuses attention on an important medieval astronomical instrument the very existence of which had been almost forgotten.

SPORE CONTENT OF THE ATMOSPHERE NEAR THE GROUND

By P. H. GREGORY

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A KNOWLEDGE of the composition of the spore flora of the air is important to agriculture because it includes crop pathogens, and to medicine because of the occurrence of respiratory allergens. Yet its composition and concentration remain undetermined because there has been no suitable quantitative method of measurement. The population of air-borne particles of plant or animal origin, which will here be called the air 'spora' (taking the Greek σπορά as a word of similar usage to 'flora' and 'fauna'), contains spores and pollens of various shapes ranging in size from 100 μ in diameter for some tree pollens down to 3–5 μ with some of the smallest fungus spores.

Methods in use for routine survey[1] generally depend either on exposing sticky surfaces (such as horizontal or vertical glass slides) and counting the spores deposited, or on exposing Petri dishes containing culture medium and counting the colonies developing after incubation. Data from these surface traps have been interpreted on the tacit assumption that the relation between the number of particles suspended in the air flowing over the surface and the number deposited on the surface is known. In wind-tunnel experiments[2] it was found that spore concentration is only one factor in determining deposition, and that particle size, wind speed and the dimensions and orientation of the trap surface can have an overriding effect on deposition. In still air a horizontal surface may sample the air according to simple rules. When the air is moving, however, the windward surfaces of the trap, such as the edges and supports, or even the trapping surface, deflect the air-stream, and also deflect the spores themselves to an extent varying with their momentum and hence with their ability to slip out of the deflected air-stream and continue their trajectories. The efficiency with which a sticky surface removes spores from the oncoming column of air varies with the speed of the wind, and

the deposit may alter very greatly with no change in concentration of the air spora. Records from surface traps are therefore difficult to interpret in terms of spore concentration per unit volume, as the wind speed at the time of deposition is usually unknown. The fact that they actually measure spore deposition on the particular surface in use and not spore concentration in the air is often ignored.

For efficient sampling of the air spora an apparatus is required which draws in a known volume of air without altering its spore content, removes all particles over the 2–100 μ size range, and leaves them in a form in which they can be examined, counted and classified.

The slit-sampler[3] of Bourdillon, Lidwell and Thomas is well adapted for volumetric sampling still air for those moulds and bacteria which grow on artificial media. Like earlier equipment, however, it is less suitable for sampling fungi and pollens from moving air out of doors. I have used the cascade impactor designed by May[4] for sampling aerosols in the field and have found it well suited for volumetric sampling of the outdoor air spora for visual inspection under the microscope. When used in the field a fin directs the orifice of the cascade impactor into the wind. A source of suction is required to draw air through the orifice, behind which is a sticky slide where the larger particles are impacted. The air is then accelerated by being drawn through three successively smaller jets each impacting on a separate slide. The catch is thus fractionated into four size-groups and deposited in narrow bands on four slides which can be mounted for microscopical examination, or removed for culture if desired. If the orifice is to collect all spores in the sampled air the speed of intake through the first jet should be adjusted to the speed of the wind; but deviations from 'isokinetic' sampling are small except for large spores. The impactor retains approximately 80–100 per cent of all spores collected by the orifice, down to about 1 μ diam.

For continuous records the cascade impactor suffers from the disadvantage that the deposit becomes too dense unless the slides are changed frequently, and for continuous operation in the open air the Hirst automatic volumetric spore trap[5] is more convenient. In this trap, which is based on the second jet only of the cascade impactor, a clockwork mechanism moves the slide past the orifice at 2 mm. per hour, so that the spores entering the trap are deposited on a 24-hour trace 48 mm. long, and diurnal changes in the air spora can be determined with an error of about ± 1 hour.

In the experiments at Rothamsted, the cascade impactor (Casella's model) has been used in several series of six consecutive four-hour runs at a height of 2 m. in the open air in dry weather. The concentration of spores and pollen of different types as directly measured reveals an air spora differing markedly from that indicated by surface traps.

Beginning at 09.00 hr. G.M.T. during each of the 24-hour periods chosen, sets of four slides were exposed in the cascade impactor for six four-hour periods, with a sampling rate of 10 litres per minute as measured by a 'rotameter', giving a total volume of 14·4 cubic metres in twenty-four hours. After mounting, the slides were scanned unstained under the oil immersion objective and the spores classified into convenient morphological groups. Identification could sometimes have been carried further, but with spore characters alone specific identification is seldom possible. The concentrations during a typical 24-hr. series are shown in the accompanying table.

Composition of the Dry Air Spora at Rothamsted, June 10–11, 1952
(Number of spores per cubic metre of air)

Spore group	Period (G.M.T.) 9–13 hr.	13–17 hr.	17–21 hr.	21–1 hr.	1–5 hr.	5–9 hr.
Unidentified minute hyaline spores	2,340	2,510	2,550	3,120	4,700	2,250
Cladosporium	3,280	5,030	1,770	2,850	1,220	1,980
Hyaline basidiospores	1,170	610	530	1,110	7,010	4,380
Grass pollens	1,030	2,120	1,210	615	280	485
Unclassified	240	430	260	780	330	430
Ustilago 'avenæ'	350	680	420	520	230	45
Erysiphe conidia	580	230	100	60	40	15
Other pollens	170	210	90	90	30	70
Coloured basidiospores	0	40	15	220	130	160
Uredospores	15	40	30	7	0	15
Total	9,175	11,900	6,975	9,372	13,970	9,830

The first slide, with the largest size-fraction, contained most of the pollens. The catch in the table represents the concentration of grass pollen at the height of the season in a position 2 m. above the ground with no great quantity of grass within a hundred yards. Uredospores of *Puccinia* spp. were not abundant in spite of the presence of wheat heavily infected with *Puccinia glumarum* within six hundred yards upwind of the trap. Conidia of the powdery mildew, *Erysiphe graminis*, may have come from a field of heavily infected spring-sown barley about fifty yards from the trapping site. Much greater concentrations of powdery mildew occurred later in the season.

The second slide, with the next smaller fraction, contained a few of the types found on the first slide. The records of *Cladosporium* illustrate the concentrations observed a few weeks before its seasonal maximum. The spores of *Cladosporium* vary widely in size and degree of aggregation. Large clumps may be found on the first slide, while the smallest individual spores often penetrate to the third slide. Spores of *Ustilago avenæ* type (including, no doubt, the morphologically similar *U. perennans* from wild grasses) also occur singly and in clumps of varying size, and form a substantial part of the dry air spora at this season. Coloured basidiospores, mainly from the Agaricaceæ and from the bracket fungus *Ganoderma*, also occurred but were only few in comparison with those found at Rothamsted[6] in August and September 1951; but again they occurred predominantly at night. Small numbers of spores of *Helminthosporium*, *Alternaria*, *Epicoccum*, *Botrytis*, *Polythrincium trifolii*, and of various other smuts, formed a regular component of the "Unclassified" group in the second fraction, but are not shown separately in the table.

The third slide contained minute hyaline spores, some of which also occur on the second slide. The most interesting of these are minute hyaline basidiospores, which were rare during the day, but reached the high concentration of 7,000 per cubic metre during the early hours of the morning (exceptionally a concentration of ten times this value has been recorded during the period 01.00–05.00 hr.). Other evidence suggests that a large proportion of these are basidiospores of the mirror yeasts, *Sporobolomyces* spp. Apparently these basidiomycetous yeasts, inhabiting the surface of leaves, discharge their basidiospores into the air in immense numbers when moist with dew, and at this time they constitute a major element of the dry air spora. Soon after dawn, as the day-

time spora becomes re-established, they disappear mysteriously. Petri dishes (9 cm. diam.) of medium exposed horizontally for ten minutes at the beginning of each period during a similar series of tests on July 24–25 gave 1, 7, 5, 4, 5 and 28 colonies respectively of *Sporobolomyces*. Their occurrence as a significant element of the air spora does not appear to have been recorded hitherto; but Mr. Merfyn Richards (*in lit.*) informs me that this observation confirms earlier experiments in which he trapped large numbers of *Sporobolomyces* on plates exposed during the night at Llandough Hospital in August 1951.

Another group of minute hyaline spores in the second and third fractions consisted of rod-shaped, jointed or septate spores. The smallest of these could possibly be confused with bacilli; but bacteria would not be expected to occur singly, free in the air, in large numbers, though some Actinomycetes might do so. Some of this fraction may consist of ascospores, but its composition is at present obscure and merits further investigation because of its potential interest in plant pathology. Some structurally characterless minute hyaline spherical spores have probably been overlooked and omitted from the count.

The fourth fraction is free from plant spores, but contains a copious deposit of smoke particles. The absence of spores among the smallest particle fraction on the fourth slide shows that all particles in the size-range of plant spores are deposited on the first three stages, and that the cascade impactor can be relied upon to give a reasonably undistorted picture of the entire air spora. The emptiness of the fourth slide gives confidence in the end point.

The cascade impactor thus allows a preliminary visual examination of the whole air spora, and shows that the smaller spores make up a very large proportion of the total number present. This was not shown by the surface traps in general use, which although giving some information of the relative abundance of large spore types at different times, are heavily weighted in favour of larger spores. For a comparison of the relative concentration of different spore types at any time the data given by surface traps can perhaps not unfairly be described as a logarithmic lie.

The species making up the smaller size fraction of the dry air spora are largely unknown, but transient clouds of small hyaline basidiospores occur during the night in high concentration. Well-marked fluctuations with time of day and changes in weather, differing with different species, are also observed, and have been studied in greater detail in both dry and damp air by Hirst[5,6], using the more convenient automatic volumetric spore trap. Simultaneous comparisons in the field between the cascade impactor and the Hirst trap have shown that the models of the latter at present in use retain spores of all sizes with a higher efficiency than previously expected.

The greater part of the solid material larger than 1 μ suspended in the atmosphere in dry weather under our conditions consists, not of inorganic dust, but of plant spores of one sort or another. It is clear that increasing knowledge of the air spora depends on the wider use of power-operated sampling equipment such as the cascade impactor for spot sampling, or the Hirst automatic volumetric trap for continuous records. The results obtained at Rothamsted show for the first time that a quantitatively complete picture of the air spora can be obtained. The possibility is opened up of applying these methods at other times and in other places and of attempting to correlate the findings with the occurrence of crop diseases and of respiratory allergy.

[1] Committee on Apparatus in Aerobiology, *Phytopathology*, **31**, 201 (1941).
[2] Gregory, P. H., *Nature*, **166**, 487 (1950); *Ann. App. Biol.*, **38**, 375 (1951), and unpublished.
[3] Bourdillon, R. B., Lidwell, O. M., and Thomas, J. C., *J. Hyg., Camb.*, **41**, 197 (1941).
[4] May, K. R., *J. Sci. Instr.*, **22**, 187 (1945).
[5] Hirst, J. M., *Ann. App. Biol.*, **39** 257 (1952), and unpublished.
[6] Gregory, P. H., and Hirst, J. M., *Nature*, **170**, 414 (1952).

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS

By Prof. GRANVILLE POOLE
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An event of great historical interest to the mining industry in Great Britain occurs this year, for the members of the North of England Institute of Mining and Mechanical Engineers are celebrating the hundredth anniversary of its formation in 1852.

Most fortunately, the first president—Nicholas Wood—was a man of outstanding ability and foresight. He was born in 1795 and in early life was thrown into the society of George Stephenson, to whom he became an assistant in that series of persevering experiments which at last resulted in the steam locomotive. Mr. Wood made the drawings from which, under its inventor's instructions, the Stephenson safety lamp was constructed. Mr. Wood also accompanied Stephenson to Darlington to engineer the Stockton and Darlington Railway. He wrote a book on the "Establishment and Economy of Railways" in 1825.

On July 3, 1852, a meeting of coal owners and 'viewers' in Newcastle resulted in the formation of a Society called "The North of England Society for the Prevention of Accidents"; but at a second meeting the title was changed to "The North of England Institute of Mining Engineers". As mining involved much engineering, it was considered desirable to include engineers among its members, and the title was later again changed to its present form.

Mr. Wood's contributions to the *Transactions* of the Institute included articles on the relative value of steam jets and furnaces to increase the ventilation of mines; on safety lamps; on the conveyance of coal underground; on sinking shafts through the water-bearing magnesian limestone and on the geology of the Northern Coalfield in Great Britain. He also paved the way for the establishment of a collegiate institution "for the cultivation, improvement and the teaching of mining science".

Nicholas Wood's inaugural address displayed that high sense of professional obligation and resolve which activated the original members and which resulted in the growth of the stature of the Institute being recognized in 1876 by the grant of a royal charter by Queen Victoria. The following tribute is to be found in this charter: "that it has during its existence of a period of nearly a quarter of a century steadily devoted itself to the preservation of human life and the safer development of mineral property, that it has contributed substantially and beneficially to the prosperity of the country and the welfare and happiness of the community".

By this time the Institute membership had grown to more than eight hundred, and in terms of the charter "included a large proportion of the leading Mining Engineers in the United Kingdom". Indeed, a review of the list of members reveals that membership was beginning to be world-wide, and the Institute was becoming a clearing-house of technical information on coal mining in many countries.

The example set by the North of England was followed by the formation of mining institutes in other coalfields, and the North of England Institute played a leading part in the establishment in London in 1889 of the Institution of Mining Engineers—now a federation of eight mining institutes from all parts of Britain.

Many historic papers have been read at the meetings of the North of England Institute. In the early years, when many disastrous explosions occurred, particular attention was paid to the ventilation of mines. John Buddle, the 'father of English mining', realizing the possible danger of using a furnace to assist in the natural ventilation, invented an air pump—the forerunner of the modern fan. A series of papers by J. J. Atkinson on the principles of mine ventilation laid the foundation of modern ventilation technology. Though Humphry Davy had improved the then safety lamp, his 'Davy lamp' was proved to be unsafe in certain circumstances and improvements were gradually brought about.

Many valuable papers on methods of working and the control of the strata are to be found in the *Transactions* of the Institute. With regard to methods of working coal seams, as the very shallow seams became exhausted it became necessary to sink deeper shafts and to work a greater area from each shaft, and the first method of really underground working was evolved, namely, the room and pillar method of mining. G. C. Greenwell in 1852 wrote "A Practical Treatise on Mining Engineering" at a time when there was practically no literature on mining in the English language. The first edition was based on a series of lectures delivered at the Newcastle College of Practical Science—the forerunner of the King's College of to-day. In passing, reference may be made to a statement made by a prominent mining engineer in the United States of America to the effect that their modern method of working is based more or less on Greenwell's ideas.

The Institute had from time to time set up committees to study specific mining problems, and in 1924 "The Support of Workings in Mines Committee" was appointed to investigate the causes of falls and accidents due to falls. In 1930 the Committee was provided with funds by the Safety in Mines Research Board for the appointment of a full-time investigator. The reports of this Committee provide a comprehensive statement of the fundamental factors determining the behaviour of the strata in mining operations.

In 1948 the Northern Divisional Strata Control Research Committee of the National Coal Board was set up. The Committee has a membership representative of the Durham and Northern Divisions of the Coal Board and of the North of England Institute of Mining and Mechanical Engineers, including members of the staff of the Mining Department of King's College, University of Durham. In this way the Institute has been enabled to continue its contributions to its historic work in this field. This is an ideal combination of observation and experiment in mines, together with academic work in the University such as photo-elastic research on plastic models of mine workings.

The early pioneers would have been astounded if they could have listened to the most recent paper read at a meeting of the Institute, when successful experiments were described in the getting of coal from very thin seams without any men on the working face at all. Such is the progress made in the mechanization of mining operations.

With such grand traditions, it will not be surprising that the North of England Institute of Mining and Mechanical Engineers is still very actively engaged in research to secure the increased safety and health and well-being of those employed in the mining industry. In addition to the research mentioned on roof control and prevention of falls of ground, there are committees on the lighting and ventilation of mines.

The research on lighting is being carried out with the view, ultimately, of being able to predict the performance of any lighting fitting under any set of mining conditions. The series of tests being done at the moment are designed to investigate the effect of shape of a mine roadway and the reflexion factor of its walls and roof on the utilization factors. This work is being done in the Mining Laboratories at King's College, Newcastle upon Tyne, and tests are also being carried out underground so as to obtain a continual correlation of results. A special photometer has been designed and constructed with which the spherical distribution of any source can be found. Investigations also cover the safety of fluorescent lamp units for use in gassy mines, and a safe signalling system on longwall faces.

The immediate object of the research on ventilation is the formulation of rules and formulæ as the basis for the design of fan drifts.

The first meetings of the Institute were in the lecture room of the Literary and Philosophical Society at Newcastle upon Tyne; but through the enthusiastic efforts of its members and with the co-operation of the coal owners, the present well-known home of the Institute, Neville Hall, Newcastle upon Tyne, was built and opened in 1872.

The beautiful Wood Memorial Hall Library and ideally arranged lecture theatre, together with the other offices provided, bear witness to the professional spirit aroused by the inauguration of the Institute, and have done much to inspire succeeding generations of mining and mechanical engineers in devotion to the task of following the objectives so clearly set out by Nicholas Wood.

In order adequately to maintain this building and to ensure continuity in research, a Centenary Appeal Fund has been opened, and it is hoped that the appeal will meet with generous response.

INTERNATIONAL SEAWEED SYMPOSIUM

An international seaweed symposium, organized by the Institute of Seaweed Research, the University of Edinburgh and the Scottish Marine Biological Association, with the assistance of corresponding delegates from Australia, Canada, Chile, France, Germany, New Zealand, Norway, South Africa, Spain, Sweden and the United States of America, was held in Edinburgh during July 13–17. The symposium, which was the first of its kind,

attracted world-wide interest, and was attended by some 160 scientists and technologists from more than twenty countries and Colonial dependencies. Lord Bilsland, chairman of the Board of Management of the Institute of Seaweed Research, presided at the opening ceremony in the Zoology Department of the University of Edinburgh and offered a warm welcome to all the members. In his address in formally opening the symposium, Mr. James Stuart, Secretary of State for Scotland, considered that many of our present industrial and agricultural problems might be alleviated to a very appreciable extent by making better use of the hundreds of thousands of tons of seaweed growing naturally around our shores, whether by way of animal feeding-stuffs or in the many other ways which are being investigated by men of science in their present research programmes.

At the first session, which was devoted to "Phycology", Dr. E. M. Burrows (Great Britain) opened the proceedings with a paper on "Intertidal Plant Populations with Special References to the Genus *Fucus*", in which she referred to the effect of habitat variation, genetical variation and hybridization occurring in *Fucus spiralis*, *F. vesiculosus* and *F. serratus*. Dr. D. de Virville (University of Paris) delivered a paper on "Algal Population Decrease on the East Coast of Cotentin", in which he discussed the main types of marine plants gathered for agricultural and industrial use from the Atlantic coast of France. The Fucaceæ (*Fucus vesiculosus*, *F. serratus* and *Ascophyllum nodosum*) are collected chiefly for manure, the Laminariaceæ (*Laminaria*, *Saccorhiza* and *Alaria* species) for the extraction of iodine, *Chondrus crispus* and *Gigartina mamillosa* for the preparation of gels, and *Zostera marina* as a packing or filling material. A progressive decrease of these plant growths, due often to excessive gathering, has been recorded in recent years, and Dr. de Virville suggested that more severe control of harvesting should be introduced in an effort to halt this serious depopulation.

Several papers were devoted to a detailed study of the seaweeds occurring in different parts of the world. Dr. E. Jaasund (Sweden) discussed the marine algæ of the north Norwegian coast-line, Dr. L. Bellon (Spain) dealt with the seaweeds of the Malagan coast, Mr. C. Primo (Spain) described the algal population of Spanish West Africa, and Dr. J. R. Nunn read a paper on the seaweed vegetation of South Africa. Contributions dealing with the purely botanical aspect of the marine algæ were given by Dr. P. Kornmann (Germany), who discussed the development of *Giffordia fuscata* (Zan), Prof. J. Feldmann (France) on the evolution of the female organs of the Florideæ, Dr. H. B. S. Womersley (Australia) on the *Macrocystis* species of southern Australia, Dr. T. Levring on the reduced forms occurring in the Swedish marine flora, and Prof. M. Chadefaud (France) on the staining techniques developed for the cytological study of the algæ. Dr. B. L. Moss (Great Britain) discussed the variation in chemical constitution occurring during the development of the Fucales, and emphasized the importance of giving accurate descriptions of any plant material submitted for chemical analysis. Mr. B. Grenager spoke on the surveying of the Norwegian seaweeds by means of the spring grab technique developed by the Scottish Seaweed Research Association.

"Algal Chemistry" was the subject for the second session, and Prof. T. Dillon (University of Galway) opened the proceedings with a lecture on "The Constitution of Some Seaweed Mucilages". He described the preparation and purification of a polysaccharide sulphuric ester from fruiting *Ascophyllum nodosum*, which contained one galactose to seven fucose residues and having one sulphate group attached to each monosaccharide anhydride unit. The galactan sulphuric esters from *Gelidium latifolium*, carrageheen moss, *Furcellaria fastigiata*, *Dilsea edulis* and *Dumontia incrassata* were also discussed. Dr. F. J. Coll (Eire) dealt with the constitution of floridean starch extracted from *Furcellaria fastigiata* and *Dilsea edulis*, and presented evidence to show, from methylation and β-amylolysis studies, that at least 50 per cent of the molecule consists of α-D-glucopyranose units linked through carbon atoms 1 and 4 as in ordinary starch. The quantitative liberation of carbon dioxide from uronic and polyuronic acids, such as alginic acid, when heated at 255° C. in the absence of any catalyst, was discussed by Dr. A. S. Perlin (Canada). The evidence suggests that the reaction is a true decarboxylation, and it has been employed for the analysis of several polyuronides, such as oxidized cellulose and starch. Dr. R. W. Watson (Canada) read a paper on "The Molecular Weight of Algin as determined by Sedimentation and Diffusion", in which the weight average molecular weight of four samples of sodium alginate ranged from 32,000 to 165,000, and appeared to be linearly related to the intrinsic viscosity. The variations in chemical composition among individual *Laminaria digitata* plants, collected at the same time and from the same habitat, were described by Mr. A. Haug (Norway), who found large individual variations in the dry matter and ash content with smaller variations in the alginate content. He emphasized the importance of these results in recording analytical data for the brown algæ. The alginate, ash, mannitol, laminarin, combined fucose and iodine content of various South African Phæophyceæ was dealt with in a paper read by Dr. J. R. Nunn, while Mr. C. W. Bonniksen (Great Britain) described the various uses of alginates and alginate materials in medicine and surgery. The nitrogenous constituents of the marine algæ were reviewed by Dr. E. Gordon Young (Canada) and Dr. G. T. Young (Great Britain). Algal peptides and proteins are difficult to extract, relatively strong alkali being required to extract 50 per cent of the total nitrogen. Dr. G. T. Young described the nitrogen distribution in various common brown seaweeds between volatile base nitrogen (chiefly ammonia), nitrate-nitrogen and residual Kjeldahl-nitrogen, and pointed out that the α-amino-nitrogen after hydrolysis was invariably less than the residual Kjeldahl-nitrogen, due probably to decomposition of the amino-acids in presence of carbohydrates. Acid hydrolysates of *L. saccharina* and *A. nodosum* contained the following amino-acids: glycine, alanine, valine, leucine, isoleucine, aspartic acid, glutamic acid, serine, threonine, proline, phenylalanine, lysine and a trace of arginine. Mr. L. E. Ericson (Sweden) spoke on the occurrence of vitamin B_{12}, folic acid, folinic acid and various amino-acids in different brown and red seaweeds from the Baltic and North Seas; the content of vitamin B_{12} in some algæ appears to be comparable with that of liver.

At the session with "Utilization" as the subject, Mr. R. W. Moncrieff (Great Britain) reviewed the present uses of alginates in foodstuffs, textiles, toilet goods, paints and engineering; recent developments include a washable flame-proof fabric and table jellies that set in hot weather. The expansion of the seaweed industry has hitherto been limited not by any shortage of seaweed or difficulty of extracting

alginates, but by the limited number of known uses for seaweed derivatives, and the development of the alginates is at present being actively studied. The utilization in the United States of agar and carragheenin, the two chief gelling agents extracted from the red algæ, was discussed by Mr. E. C. Jertson (United States), and Dr. D. C. West read a paper on "A Survey of Certain Seaweeds of Commercial Importance in South West Nova Scotia". The survey revealed the presence of approximately 200,000 tons of rockweed, 900,000 tons of *Laminaria* spp., while in 1950 almost 8,000,000 lb. of *Chondrus* were harvested. Recolonization of these species was also discussed. Industrial applications of the seaweeds in Spain were dealt with by Dr. J. Aravio-Torre, who spoke of the rapidly increasing production of agar from 1944 to the present time, production in 1951 amounting to some 62,000 lb.; the brown seaweed industry, however, has not grown to the same extent. The session on utilization was concluded by Mr. C. J. E. Hand (Great Britain), who described the results of feeding various seaweed meals to laying hens; the introduction of 10 per cent of seaweed meal into the basal ration, although causing increased water consumption, did not produce any ill-effect upon egg production, egg weight and shell weight in small-scale trials of 100 days involving groups of four birds. When 15 per cent of the basic ration, however, was replaced, water consumption was further increased, and live-weight and egg production decreased.

The final session, entitled "World Seaweed Resources", was introduced by Dr. F. N. Woodward (director of the Institute of Seaweed Research), and the following spoke on the seaweed resources of their respective countries: Dr. H. B. S. Womersley (Australia and New Zealand), Dr. D. C. West and Dr. G. M. Shrum (Canada), Mr. E. C. T. Holsinger (Ceylon), Prof. H. Etcheverry (Chile), Dr. S. Lund (Denmark), Mr. D. T. Flood (Eire), Prof. J. Feldmann (France), Prof. C. Hoffmann (Germany), Mr. F. T. Walker (Great Britain), Dr. J. R. Nunn (South Africa), Dr. L. Bellon (Spain), Dr. T. Levring (Sweden), and Mr. G. W. Anderson (Zanzibar). Papers from the following authors, who were unable to attend the symposium, were read by title: Prof. T. Rayss (Israel), Dr. S. Suto (Japan), Prof. T. Braarud (Norway), Dr. G. T. Velasquez (Philippines), and Drs. K. S. Pillai and N. S. Varier (Travancore–Cochin).

Many members contributed to the discussion on each group of papers at the end of the various sessions, and a résumé of these discussions, together with abstracts of the complete set of papers presented and read by title, will appear in the "Proceedings" of the symposium, copies of which should be available before the end of this year. Dr. M. Knight (Great Britain), Dr. T. Levring (Sweden), Prof. C. G. C. Chesters (Great Britain), Dr. E. Gordon Young (Canada), Prof. E. L. Hirst (Great Britain), Mr. E. C. Jertson (United States) and Dr. F. N. Woodward (Great Britain) presided at the various sessions.

There were three excursions connected with the symposium. On July 13, a joint meeting with the British Phycological Group was held at St. Andrews, where members and their friends visited the Gatty Marine Laboratory and were given ample opportunity of studying the marine flora of that part of the coast. On the afternoon of July 15, members visited the Institute of Seaweed Research, Inveresk, Midlothian, to inspect the laboratories and workshops. Mr. Philip Jackson, deputy director of the Institute, gave a brief description of the different methods developed for harvesting sublittoral brown seaweeds, and on the morning of July 17 demonstrations of this equipment were held at Dunbar and Fisherrow.

There were also three social events held during the evenings. On July 14, delegates were provided with an opportunity of meeting in very pleasant circumstances at a cocktail party given by the Secretary of State for Scotland, while on July 16 the Magistrates and Council of the City of Edinburgh showed their interest in the purpose of the symposium by holding a reception in honour of its members in the City Chambers; in the absence of the Lord Provost, members were welcomed by Senior-Bailie James Campbell, and Mr. E. C. Jertson replied for the visitors. On July 15, a dinner was held in the hall of the Royal College of Surgeons, where the principal speakers were Dr. F. N. Woodward and Sir Alexander Gray, professor of commercial and political economy and mercantile law in the University of Edinburgh.

Dr. T. Levring expressed the feelings of members when, at the closing session, he spoke of the success of the symposium, not only from a scientific but also from a social point of view. He suggested that the next symposium should be held in Norway three years hence, and this motion was very cordially supported.

E. T. Dewar

NEWS and VIEWS

Commonwealth Scientific and Industrial Research Organization: Mr. G. A. Cook

Mr. G. A. Cook is retiring from the post of secretary of the Commonwealth of Australia Scientific and Industrial Research Organization, after thirty years with the Organization and its predecessors, the Institute of Science and Industry and the Council for Scientific and Industrial Research. Mr. Cook graduated at the University of Melbourne with first-class final honours in science and in mining engineering. After service in the First World War, he worked with Sir Edgeworth David collating geological information from the French and Belgian Geological Surveys, and on his return to Australia undertook research in several phases of the mining and metals industries. When Mr. Cook joined the Institute of Science and Industry as scientific abstractor in 1922, there were only two people with a scientific training on the staff. He has seen the growth of that Institute into the present Organization, with a total staff of more than three thousand, including eleven hundred scientists. In 1927 he was appointed assistant secretary to the Council for Scientific and Industrial Research, and for many years was also officer in charge of its Information Service. He succeeded Mr. G. Lightfoot as secretary in 1944. Mr. Cook has always kept in personal touch with all phases of the Organization's work, and his long service as an administrator has given him wide experience of science and its organization. He has taken a particular interest in making the results of scientific research available to industry both as an editor of scientific publications and as a writer of non-technical accounts for the general reader.

The administrative work of the Commonwealth Scientific and Industrial Research Organization will now be the responsibility of four senior members of the secretariat: Mr. F. G. Nicholls, secretary (general administration); Mr. G. B. Gresford,

secretary (physical and industrial sciences); Mr. W. Ives, secretary (agricultural and biological sciences); and Mr. M. G. Grace, secretary (finance and supplies).

Agricultural Census in Iraq

THE first agricultural census to be undertaken in the Middle East is now nearing completion in Iraq. This census, organized and directed by Dr. K. G. Fenelon, who is Government statistician, will provide information much needed for the planning of developments made possible by the rapidly increasing revenues from oil royalties. The statistics now being collected relate to such matters as land utilization, land tenures, farm labour, size of farms, crops and the livestock carried on farms or owned by nomadic tribes. Special emphasis has been placed on the need for early publication, and already data for certain districts are available. The census is a nation-wide survey and has necessitated a farm-to-farm visitation by specially trained enumerators drawn largely from the ranks of teachers and college students on vacation. As the majority of the farmers are illiterate, the verbal information given by them has had to be entered on the forms by the enumerators themselves and, where necessary, translated into Arabic from Kurdish or Turkish. In taking the census, which began in June and is expected to be completed in November, many difficulties have had to be overcome, especially in those districts where land settlement is not yet completed or where the flocks of nomadic tribes have to be enumerated. Many of the farms and villages are far removed from any main road, and though motor transport has been used where possible, other means of transit, such as mules in the mountains, camels in the desert or small boats in the marsh-lands, have been employed to reach these more remote villages.

Nuffield Botanic Garden, London

WHEN the Nuffield Foundation moves into its new headquarters at Grove House, Regent's Park, London, a large part of the four acres of gardens in which the house stands will be made available by the Foundation to University College, University of London, for botanical research. The garden will be known as the "Nuffield Botanic Garden". In the first instance, research is envisaged which will deal with some of the genetical aspects of the taxonomy of native British species and also with the problems associated with intersexes in plants, under the direction of Dr. J. Heslop Harrison. It is expected that later developments may include both ecological and experimental studies of native species, particularly those of taxonomic and ecological interest. Botanists will note with appreciation this important extension of the interests of the Nuffield Foundation to the field of experimental taxonomy.

Television in Wales and Scotland

ON August 15, the Postmaster-General, Lord De La Warr, opened the new television transmitting station for South Wales at Wenvoe, near Cardiff, thereby completing the first stage of the installation of the British television network. At the present time, this station is operating with a 5-kW. transmitter, but it will be raised to at least ten times this rating as soon as possible. Two days later, the Scottish station at Kirk o' Shotts was brought into full high-power operation by the completion of the new vision transmitter supplied by Electric and Musical Industries, Ltd., which is capable of delivering 75 kW. into the aerial. The corresponding high-power sound transmitter, supplied by Standard Telephones and Cables, Ltd., has a carrier output of 18 kW. at 100 per cent modulation. These installations replace the low-power standby transmitters which have been in use since the Scottish television service was opened last March (see *Nature*, March 22, p. 482). When the corresponding high-power transmitters are completed at Wenvoe, Scotland and Wales (including the west of England) will have the most powerful television stations in Britain and, it is thought, in the world. The completion of these stations will bring the British television service within the reach of some 40 million people, or about four-fifths of the population of the United Kingdom.

Social Insurance and the Problems of Poverty

THE Beveridge report on social insurance and allied services in Great Britain defined freedom from want as the basic purpose of the social security scheme. A recent broadsheet issued by Political and Economic Planning (No. 344. "Poverty: Ten Years After Beveridge") examines the extent to which efficient and permanent defences against poverty have been built up in Britain in fulfilment of this purpose during the past ten years. Attention is focused principally on the information and methods available for giving a definite meaning to poverty and thus fixing a poverty standard which can be used both by investigators in charge of social surveys and by administrators in determining the level of social payments. In particular, an attempt is made to give a clearer meaning to the term 'subsistence minimum' and to indicate the steps involved in arriving at such a minimum. At present, insufficient information is available to enable a satisfactory subsistence standard to be worked out, although the proposed inquiry of the Ministry of Labour into family budgets, intended to supply facts for a revision of the index of retail prices, could supply much of the missing information. The use of family budget data is the only practical way, the broadsheet points out, of limiting the arbitrariness of judgments for items other than food, and there is a strong argument for adding a few specific items, such as postage, shaving and hairdressing, laundry, contraceptives, sanitary towels, certain subscriptions, soap and other cleaning materials, to the list of necessities usually adopted in a standard, on the ground both that they occupy a consistent place in family budgets and that 'by conventional standards' they are necessities. In the last resort, decisions must be based on contemporary views about the lowest living conditions that are tolerable in the community. Whatever policy of preventing poverty is adopted, a carefully determined subsistence standard is essential for its success.

Sociological Bulletin

THE first issue of the new journal of the Indian Sociological Society, entitled the *Sociological Bulletin* (1, No. 1; 1952. Pp. 88; from the Indian Sociological Society, Jamnalal Bajaj Nagar, Kurla Road, Andheri; Rs. 3, or 4*s*.), is given a characteristic flavour of its own by the essay it includes by Prof. D. P. Mukerji on "Sociology in Independent India". The subject has, he thinks, been ignored hitherto by the Government of India, and insufficient use has been made of sociologists in the drafting of legislation. Nevertheless, sociology can now be offered in the competitive examinations of the Union Public Service Commission, which will give it a new status. Still

more important than this, however, the shaping of a new society in India depends in large measure on the intelligent analysis of social trends and, in particular, on what Prof. Mukerji terms "culture-assimilation", and this is one of the more important tasks for the Indian sociologist to accomplish. Prof. Mukerji and his colleagues see themselves as members of a society attempting to avoid domination by both American and Russian culture and civilization. American sociology is sometimes presented to the Indian scholar as "a scientific discipline to save the world from Marxism"; but Dr. M. N. Srinivas roundly declares in his article on "Social Anthropology and Sociology" that, for all their claim to be 'scientists', American sociologists implicitly, but none the less deeply, believe in the values of contemporary America. The Indian sociologist, therefore, appears to be embarking on an attempt to develop his own study in his own way, rejecting both the American and the Russian patterns. His colleagues throughout the Western world will watch his work with interest and sympathy.

Japanese Researches in Biophysics

The Research Institute of Applied Electricity, Hokkaido University, Sapporo, Japan, has followed up its first monograph, entitled "Theory and Application of High Frequency Phenomena" (see *Nature*, **167**, 102; 1951), by a second interesting monograph on "Some Researches on Biophysics" (Monograph Series No. 2; pp. 69; August 1, 1951). This latter publication, which is edited by Y. Asami, contains six articles: the first two are concerned with the effects of radiation on proteins, the next two with the methods of excitation of and electrical conduction along nerves, and the remaining two with physio-chemical problems. M. Wakabayashi and F. Kawamura describe what is probably the first reliable investigation of the effects of large doses (10^5–10^6 r.) of X-rays on the serum proteins. The chemical changes produced were examined, and the results obtained were compared with the changes produced by ultra-violet radiation or by heating. The rapid vapour-pressure method of determination of the water content of easily purified proteins, devised by K. Hirota and F. Kawamura, is the subject of the other article on proteins, and the results of the application of the method to gelatin and fresh muscles support Wakabayashi and Kawamura's work. The other articles deal with the following topics: the spike and dome potential observed in the oil/saline-water nerve model; study of the discharge pattern of Hering's sinus nerve and the excitation mode in the chemoreceptors of the carotid body; polarographic measurements of oxygen concentration *in vivo*; and dielectric absorption and anomalous dispersion of polar solutions.

Forest Taxation in New Zealand

In Information Series No. 11 of the New Zealand Forest Service (Wellington, 1950), Mr. M. B. Grainger discusses the question of forest taxation, a recurring problem which appears still to be far from settled, since opinions differ widely on what should be a fair burden to lay upon forests, the produce from which is essential to all types of the human race in one form or another, quite apart from industrial utilization. Private forests, especially commercially owned private forests, as apart from the Government forests, play an important part in the forest economy of New Zealand. As Mr. Grainger says, "The National Forest policy has always envisaged private forests playing a significant part in New Zealand's timber and wood economy and therefore the Forest Service has sought to encourage good standards of forest management". The methods of taxing forest land and forest operations have proved increasingly difficult during the past thirty years and have come in for a good deal of criticism, certain anomalies, not unknown in other countries, having become apparent. It must be obvious to all that a property like a forest cannot be looked at from the same point of view as a house or industrial buildings, or even a farm with its short-term growing crops, and so forth. The forests, even short-rotation crops of 15–20 years or so for firewood, paper pulp, etc., are not so easily assessed for taxation purposes. There is no doubt that excessive taxation based on inability to grasp the different growing conditions and the longevity of these conditions have been in the past, and are at the present day, a serious threat to the perpetuation of the forest in parts of the world where this maintenance is of the first importance to the population of the country concerned. Before he formed the opinion that contemporary tax practice in New Zealand is prejudicial to good forestry, Mr. Grainger visited a number of selected European countries. In this brochure taxation methods in Great Britain, Sweden, Finland, France and Norway are briefly dealt with, the various systems compared and then contrasted with those of New Zealand, and proposals made with reference to the latter country.

Planets and Sunspots

The third part of K. G. Meldahl's paper on "Tidal Forces in the Sun's Corona due to Planets", which has recently been published (pp. 14 of text, and pp. 16 of illustrations. Copenhagen: Berlingske Forlag, 1952), carries on the work of the other two parts, published in 1938 and 1949 respectively (see *Nature*, **144**, 726 (1939) and **165**, 301 (1950); and also **166**, 1058 (1950)). In Part 2 it was shown that a period of 308·52 years has a powerful influence on the vertical tides, confirmatory evidence of which was found in the observations of auroras and sunspots. It was also pointed out that the partial force periods of the sun include one of 22·38 years, which approximates to Hale's estimated period for the changing polarity of the spots, and in Part 1 it was suggested that the disturbance which caused the spots moved along the meridian plane or nearly so. It remains to be seen whether Hale's observations will confirm Meldahl's views. While Part 3 repeats some of the results previously obtained, it also contains many new features and includes a separate portion with sixteen illustrations. These show that there is a preponderance of meridional forces pointing towards the equator, with maxima at about 45° latitude, and it is suggested that there may be corresponding currents in the coronal gases, such currents being subject to similar centrifugal forces in addition to the ordinary forces due to the sun's rotation. A number of photographs of solar eclipses are reproduced for 1860–1901, and these show the diamond shapes in the corona with four cusps at 45° latitude, thus corroborating the meridional forces already referred to. Certain hydrodynamic phenomena—in particular the case of a fluid surrounding a rotating sphere—are outlined in two illustrations, and it is found that a number of configurations resembling those found on the sun are in evidence in the experiments. Disappointed with the lack of satisfactory explanations of currents

in the corona, Meldahl has formulated a hypothesis—admittedly rather speculative though partly based on observational data—leading to his "Characteristic Curves" for the sun regarded as a centrifugal fan, and this is explained in two illustrations and also at length in the text. Deductions with this hypothesis as a basis seem to explain a number of phenomena associated with eclipses of the sun at various times; it will be interesting to learn whether the hypothesis is supported by observations of the eclipse of February 25, 1952.

Research Developments by British Thomson-Houston Co., Ltd.

An interesting illustrated article appears in the May–June issue (23, No. 3) of *B.T.H. Activities*, in which Mr. L. J. Davies, the director of research, reviews the work of the British Thomson-Houston Research Laboratory during 1951. New materials for use at high temperatures and new glasses, including a new phosphate glass for sodium-vapour discharge-lamps and tellurite glasses of unusual properties, have been developed, and the work of the Physical Analysis Group has been expanded considerably. The creep properties of alloys for steam turbines and gas turbines have been the subject of special interest and study. Work on the applications of lead sulphide photocells has resulted in the development of an infra-red radiation pyrometer for the measurement of surface temperatures down to 150° C. Other instruments developed were infra-red photoelectric relays and a halogen vapour leak detector. Single-crystal germanium has received considerable attention, and a new p—n junction-type germanium rectifier capable of handling considerable power has been produced. Improvements have been made in valves for marine radar, and new glass toroids of reduced size but which allow full use to be made of the magnetic flux available have been devised for use in betatrons and proved successful. A 2-MeV. impulse generator has been erected in the heavy plant factory at the Company's works at Rugby. It incorporates specially designed aluminium electrodes which together with the generator form a standard of capacitance for use with impulse voltages up to two million. The article concludes with a description of some very interesting developments in electroluminescence and in lamps of the high-pressure gas and vapour, fluorescent, germicidal and other types.

Libraries of the University of Leeds: Report for 1950–51

The annual report of the librarian of the University of Leeds for the session 1950–51 (pp. 12; from the University; 1951) records a total of 337,787 volumes and 151,645 pamphlets in the collections at June 30, 1951. Accessions during the year totalled 14,435 volumes, 3,042 pamphlets and 25,883 parts of periodicals, a decrease of 8 per cent on the previous session. Catalogue additions totalled 47,774, an increase of 19 per cent; loans to readers, 78,358, an increase of 10 per cent; and inter-library loans totalled 1,294 books borrowed and 1,495 books lent, increases of 31 and 10 per cent, respectively. On a quinquennial visit on November 15, the University Grants Committee saw the Brotherton Library, and the Medical Sub-Committee the Medical Library. A revised list of periodical holdings in the Brotherton Library is being prepared for the British Union Catalogue of Periodicals, and when this list is complete, in about two years time, it may be published separately as a handlist of periodicals in the University Library. In view of the forthcoming revised edition of the Short Title Catalogue of English books, 1475–1640, a list has been prepared of the items in the Catalogue which are possessed by the Library and also of a few items possessed by the Library which are not in the first edition of the Catalogue. The use made of the Medical Library has further increased in spite of serious difficulties due to inadequate accommodation. The library of the Institute of Education moved in August 1950 to more commodious quarters in University House, and the Library of the Department of Textile Industries became a sectional library under the central library administration from September 1. A new departmental library was started during the session in the Department of French, and the Library of the Department of Adult Education and Extra-Mural Studies will be incorporated as a section of the University Library from the beginning of the next quinquennium.

Society for Visiting Scientists: Annual Report for 1951–52

The report of the Secretary of the Society for Visiting Scientists, to the fifth general meeting, on July 24, refers to the reduction from £4,000 to £2,000 of the grant from the British Council, necessitated by the reduction of the Government grant to the latter body. The task of raising a sum of £4,000 for the financial year, starting on April 1 this year, has been undertaken by the honorary treasurer, Prof. A. Haddow, mainly by an appeal to industry (from which £900 has already been received). The Society is now registered as a charity, and four organizations have already signed a deed of covenant with the Society. Some saving has been effected by the reduction of the Society's activities. With the co-operation of the Science and Engineering Department, the Student Department and the Welfare Department, an Overseas Science Students Association, with a membership of 120, has been founded to welcome postgraduate science students from overseas and to bring them into closer contact with the scientific life of Great Britain and with one another. This Association is affiliated to the Society for Visiting Scientists. Prof. A. V. Hill is succeeding Sir Harold Spencer Jones as president of the Society, which has a membership of 1,900, but the report emphasizes that membership of British scientific workers is not increasing as much as is desired.

Reference List of Cultures of Protozoa

The Society of Protozoologists is establishing a centre of information for available cultures of free-living and parasitic Protozoa and algal flagellates maintained in various laboratories in the United States and other countries. This system will relieve the scientific worker who has isolated, or is maintaining, the cultures of the need to give technical information every time that a culture is requested. Those who are willing to co-operate in the formation of this reference list and are willing to send cultures to other investigators should request from the Committee on Cultures of Protozoa a data card for each species that is being maintained in their laboratory. On each card pertinent information regarding the origin of the culture, procedures for maintenance, key references and other essential data will be

entered. These cards will form the basis for an alphabetical file of species and a taxonomical cross-reference list. In addition, the card will indicate where the culture may be obtained. Upon request for a certain species, a photostatic copy of the master card will be sent upon payment of a nominal fee. This information will be made available to all who are interested in obtaining cultures. The chairman of the Committee on Cultures of Protozoa is Dr. L. Provasoli, Haskins Laboratories, 305 East 43rd Street, New York 17, N.Y.

U.S. National Science Foundation: Research Grants

The National Science Foundation (2,144 California Street, N.W., Washington 25, D.C.) has announced the award of the final group of research grants, approved during the fiscal year which ended on June 30, in its programme for the support of basic research. This group consists of twenty-nine grants, totalling 263,535 dollars, for biological and physical sciences, and the fields covered are as follows: astronomy, chemistry, developmental biology, earth sciences, engineering, environmental biology, experimental psychology, genetic biology, mathematics, microbiology, molecular biology, physics, regulatory biology, and systematic biology. Altogether ninety-eight grants have been awarded during the past year, totalling 1,181,175 dollars, and these were distributed to sixty institutions in thirty-five States and Hawaii, the average grant amounting to 11,032 dollars for 1·9 years, or about 5,800 dollars a year. While grants were selected primarily on the basis of scientific merit, the Foundation is attempting in its programme for the support of research to encourage the development of research activities in smaller institutions throughout the United States. This policy is aimed not only at increasing the research potential of the nation, but also at improving the teaching of science at both the graduate and undergraduate levels. Application forms for both predoctoral and postdoctoral graduate fellowships for the academic year 1953–54 can be obtained after October 1 from the Foundation. Completed applications must be returned to the Fellowship Office, National Research Council, by January 5, 1953. The special examination for predoctoral candidates will take place at various places throughout the United States on January 31, 1953.

National Smoke Abatement Society

The annual conference of the National Smoke Abatement Society will be held at Portsmouth during September 24–26 under the presidency of Alderman F. E. Tylecote, of Manchester, emeritus professor of medicine in the University of Manchester. The Des Voeux Memorial Lecture this year will be by W. R. Hornby Steer, standing counsel to the Society, on "Smoke and the Law". The programme includes reports on air pollution and cancer of the lung (Dr. Percy Stocks), prevention of domestic smoke (Dr. J. L. Burns), work of the Fuel Research Station (Department of Scientific and Industrial Research) on atmospheric pollution (Dr. E. T. Wilkins), a session on incentives for the prevention of industrial and domestic air pollution, and a discussion on pollution problems in the iron and steel industry, to be opened by Prof. R. J. Sarjant. Further information can be obtained from the Society, Chandos House, Buckingham Gate, Westminster, London, S.W.1.

Announcements

We regret to announce the death, on September 15, of Sir Richard Gregory, Bart., F.R.S., editor of *Nature* from 1919 until the end of 1938, aged eighty-eight.

The Medical Research Council has appointed Dr. J. C. Gilson to be director of its Pneumoconiosis Research Unit at Llandough Hospital, near Penarth, Glamorganshire. Dr. Gilson, who was formerly assistant director of the Unit, takes the place of Dr. Charles Fletcher, who resigned on August 31 to take up an appointment at the Postgraduate Medical School of London.

A Joint Committee consisting of representatives of the Royal Society and the University of Cambridge has appointed Dr. R. J. Eden, of the University of Cambridge, to be Smithson Research Fellow, for four years in the first instance, from October 1. Dr. Eden will work in the University of Cambridge on the theory of fundamental particles.

The biennial Conference of the Oil and Colour Chemists' Association will be held at Eastbourne during June 3–5, 1953. There will be three technical sessions, each composed of three papers, which will be under the general title of "The Optical Properties of Films of Surface Coating Materials". These papers are being arranged by the Honorary Research and Development Officer of the Association, Mr. P. J. Gay, Hangers Paints, Ltd., Stoneferry Works, Hull.

The tenth annual meeting of the Electron Microscope Society of America will be held at the Statler Hotel, Cleveland, Ohio, during November 6–8. Programmes and abstracts of papers are available from C. E. Willoughby, DuPont Experimental Station, Wilmington 98, Delaware. Information about local arrangements can be obtained from Mrs. Mary S. Jaffe, LDL-85, General Electric Company, Nela Park, Cleveland 12, Ohio.

A new multiple fellowship for long-range investigations in synthetic organic chemistry, with general emphasis on chemotherapy and in particular the preparation of compounds for combating viruses and tumours, has been established at the Mellon Institute of Industrial Research, Pittsburgh, by the firm of Parke, Davis and Co., of Detroit. The leader of the research group is Dr. A. M. Moore, who is a specialist in the synthesis of potential drugs and in the classification of organic compounds, and with him are three senior Fellows (Drs. R. S. Tipson, Alice G. Renfrew and M. S. Morgan) and one Fellow (Pauline C. Piatt). Several other scientific workers and assistants are also joining the group.

We have received from Messrs. J. E. Buck and Co. a convenient little map measure which will be very useful in measuring the distance of one's route on a one-inch or smaller-scale map. The instrument, which easily goes in the vest pocket, is made of plastic material covering metal wheels. It is set for a scale of one inch to a mile. This measure can be obtained direct from the makers at 47 Brewer Street, Piccadilly, W.1 (5*s.*, post paid).

Erratum. In the communication "Micro-spherical Aggregation of Barium Sulphate" in *Nature* of September 6, p. 423, by D. I. Stock, in column 2, line 3, for "of the spheres" read "of the barium sulphate within the spheres".

FOURTH CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING

VISITING Britain for the first time, the International Association for Bridge and Structural Engineering held its Fourth Congress in Cambridge during August 25–30. Immediately before the opening session in the Senate House, attended by some six hundred members from twenty-four countries, a Congregation of the University of Cambridge was held at which the Vice-Chancellor, Sir Lionel Whitby, conferred honorary degrees on Lord Woolton, Lord President of the Council and president of the Congress, Prof. F. Stüssi, Rector of the Swiss Federal Institute of Technology and president of the Association, and Prof. F. Campus, Rector of the University of Liège and senior vice-president of the Association. In introducing Lord Woolton, the Orator said that though he had attained many honours and offices yet surely that day marked the climax of his life; in his capacity as president of the Congress he could scarcely be denied the title of Pontifex, which even Caesar himself was proud to assume: "innumeris", as Ovid put it, "accessit titulis Pontificalis honor".

Lord Woolton, in opening the Congress, said that we are at the beginning of a new era which may well revolutionize the industrial processes of the world and, in doing so, restore and enhance the standard of living even of the most favoured States. Fundamental research has far outstripped our present capacity and our will to use it. We must develop a new attitude of mind on this subject, an attitude that is hostile to waste of either material or labour and is intolerant to the waste of knowledge.

In addition to the opening and closing meetings, six working sessions were held at which the attendances remained high throughout the week. They dealt with the following topics.

(*A*) *General Questions.*

I. *Safety of structures.* Loading of bridges and structures; dynamic problems; plasticity and the plastic design of structures.

II. *Development of methods of calculation.* Analytical methods of the theories of elasticity and plasticity; approximate methods; experimental stress analysis; instability.

(*B*) *Metal Structures.*

I. *Fundamental principles.* Welding and welded connexions; fabrication and erection of large welded girders.

II. *Practical applications.* Problems in steel building construction; structures in light metals; special erection methods; details of design.

(*C*) *Concrete and Reinforced Concrete Structures.*

I. *Fundamental principles and the properties of concrete.* Composition and properties of concrete; effect of repeated and continuous loading; creep; corrosion of concrete and reinforcement.

II. *Current problems of concrete and reinforced concrete; prestressed concrete.* Theory of formation of cracks; non-uniform shrinkage of concrete; combined bending and torsion; design and execution of prestressed concrete structures.

Not surprisingly, since the Congress was meeting in the Engineering Laboratories of the University of Cambridge, the topic which aroused perhaps the greatest interest was the development of the theory of the behaviour of metallic structures loaded beyond the elastic range and the derivation of the plastic method of designing steel structures, a branch of engineering science in which Great Britain is far ahead of other countries. At a conversazione, held in the Laboratories where the members of the Congress were entertained by Prof. J. F. Baker and the members of the teaching staff of his Department, could be seen, among the thirty-four research exhibits in the structures and allied laboratories, sixteen showing the steps taken in the development of the plastic theory during the past sixteen years. These ranged from the original apparatus on which the early work was carried out before the Second World War, making possible the efficient design of air-raid shelters and devices for protecting production from air attack, through the investigation of the plastic behaviour of continuous stanchions which still proves an intractable problem, to examples of building structures recently erected in Great Britain in which a saving of 30–40 per cent of steel has been obtained by applying the plastic method of design and adopting the attitude of mind demanded by Lord Woolton.

Of no little interest, particularly to the members from abroad, was the Department of Engineering itself, with its seven hundred or so students, large workshops and comprehensive laboratories including a magnificent five-story block rapidly nearing completion, which, in its equipment and research activity, compares favourably with the best in their own countries.

Among the papers on plasticity from the Cambridge school, one by B. G. Neal and P. S. Symonds described a new technique for determining collapse loads. The plastic method of design is so powerful when applied to a redundant structure because it is based on the condition which occurs when sufficient plastic hinges have been formed to transform the structure into a mechanism. Any one structural form has a number of possible modes of collapse. In an uncomplicated form such as a single-story portal, the modes are obvious, but in multi-story frames, for example, this is not so. The authors pointed out, however, that all the possible modes can be regarded as built up from a certain number of simple mechanisms. This has led to the development of a new and powerful technique for determining the plastic collapse loads by combining the simple mechanisms in a systematic manner so as to reduce the corresponding load to its least possible value. Another of these papers, by M. R. Horne, showed that further economies in material can easily be obtained by the plastic method by designing members of varying cross-section such that the total weight shall be an absolute minimum. A paper by A. Lazard described the latest French tests on plain beams of various sizes, and extended the discussion to plate-web girders. By surveying all previous tests, the author distinguished between the points which are definitely established and those which are still in dispute. Prof. E. Torroja (Madrid), *rapporteur général* of the first section of the Congress, concluded that the importance and interest of this whole subject of plasticity as applied to structures is such that there is justification for a vast systematic research programme. It seemed evident, from the exhibits at the conversazione, that the work carried out in Cambridge for so long has been systematic, designed to push forward the boundaries of knowledge as far as possible in an unbroken line; bu there is no doubt that one of the most far-reachi

results of this Congress will be the further spread abroad of research into the plastic behaviour of structures.

There were many useful and fascinating papers of a more practical nature, notably that by H. Shirley Smith (London) on the influence of erection methods on the design of steel bridges, and one on thin-walled (light-gauge) structures in America by G. Winter (Ithaca, U.S.A.). The latter formed a link with the more theoretical papers, such as that by Ch. Massonnet (Belgium) on the buckling of webs. It was Winter who pointed out in the discussion that too much effort has always been expended on the consideration of the somewhat ill-defined point where buckling begins, whereas what is important to the engineer is not this point—since the member still continues to support its load—but the ultimate carrying capacity of the member. It appears, therefore, that it is not only in framed structures, where plasticity rules, that the engineer will turn in future to the new philosophy of design and will adopt the collapse condition as the criterion.

Much interest was shown in the two working sessions dealing with concrete and reinforced concrete structures, though no striking new work was reported. The vast and complex problem of the corrosion of reinforcement was discussed and, in view of the new philosophy of design mentioned above, the need was stressed for moving the emphasis in research from the behaviour of simple members to a consideration of the ultimate strength of continuous systems in reinforced and also in pre-stressed concrete.

In addition to the working sessions there were many social engagements and visits. Cambridge was in its most delightful mood, though the sun did not shine during the garden party given by the Master of Christ's College; the visitors certainly took away with them to London, where a further programme of visits and functions had been arranged, an impression of academic calm which might not survive a visit in October, when the seven thousand undergraduates and the 675 teachers are in residence.

SPACE TRAVEL

A PUBLICATION of the British Interplanetary Society, "The Artificial Satellite"*, edited by L. J. Carter, includes the proceedings of the Second International Congress on Astronautics, held in London last year (see *Nature*, **168**, 733; 1951); a very full account is given and following this are six of the papers read at the Congress. The first of these, "The Artificial Satellite", by L. R. Shepherd, technical director of the British Interplanetary Society, emphasizes the necessity for setting up a project for the development of satellite vehicles under civilian control. He points out the immense advantages of such vehicles as scientific research stations and observatories, though of course from the astronautical point of view their real advantage would be found in their use as a springboard for interplanetary flight. The subject is very carefully discussed from various points of view, and the conclusion is reached that the most feasible project would be to have space stations circling the most important planets and satellites, ion rockets plying between the space stations, while normal rockets, either conventional or nuclear-powered, would operate between the planetary surfaces and the space stations. The importance of setting up a supply base on the moon at an early stage in the development is emphasized. Propellants and material would be manufactured there, and it would be very much easier to supply an earth-satellite station from the moon than from the earth.

Lyman Spitzer, jun., of Princeton University Observatory, has a paper "Interplanetary Travel between Satellite Orbits", which shows what we might expect from a rocket powered by nuclear energy.

Among other papers may be mentioned that on "Descent from Satellite Orbits using Aerodynamic Braking", by T. Nonweiler; "Meteor Hazards to Space-Stations", by Michael W. Ovenden; "Minimum Satellite Vehicles", by K. W. Gatland, A. M. Kunesch and A. E. Dixon; and "Establishing Contact between Orbiting Vehicles", by R. A. Smith. Summaries of eleven other papers presented by various societies in America and Europe are also published.

A recent issue of the *Journal of the British Interplanetary Society* (**2**, No. 3; May 1952) contains a number of papers which deal mainly with astronautics. D. Hurden contributes the first of these under the title, "The Design of Rocket Motors", which gives elaborate details for designing a liquid-fuel rocket motor. C. A. Cross has a paper with the title, "The Fundamental Basis of Power Generation in a Satellite Vehicle", which deals with artificial satellites. He suggests that probably the first of these will be small unmanned rockets, telemetering instrument readings to the earth; these may ultimately develop into unmanned bases for orbital refuelling which will lead to the exploration of some of the members of the solar system. As the various projects of such satellites require an electrical power source, and the transportation of material to them would be a formidable matter, the author examines the possibilities of utilizing the sun's radiant energy and shows that such a method is fundamentally sound and a practical proposition. Patrick A. Moore deals with a number of asteroids which have made comparatively close approaches to the earth in recent times and suggests that some of these may be used in astronautics as refuelling stations. In the United States this subject has recently been receiving serious consideration.

* The Artificial Satellite. (Proceedings of the Second International Congress on Astronautics, London 1951.) Edited by L. J. Carter. Pp. iv+74. (British Interplanetary Society, 12 Bessborough Gardens, London, S.W.1, 1952.) 5*s*. 6*d*.

THE MILITARY COLLEGE OF SCIENCE, SHRIVENHAM, WILTS

WITHIN the past few months, there have been announcements of two interesting innovations connected with the Military College of Science, Shrivenham. In July the War Office published details of the scheme, outlined by the Secretary of State for War in his speech on Army Estimates, for direct entry to the College.

This new scheme aims at increasing the number of Regular Army officers with scientific and engineering qualifications, a step rendered necessary because of the ever-growing complexity of modern weapons and methods of war. A candidate who is qualified to begin a course of study for a University of London (external) degree, on passing the Regular Commissions Board, will be called up for National Service in September and will spend a year in basic training, at an officer cadet school and as a National Service officer in an active unit, before joining the College. At Shrivenham he will become, for all intents and purposes, an undergraduate reading for a London

(external) degree in natural science or engineering. His regular commission will be granted at the end of his second year at the College, and on graduation his seniority will be antedated to agree with that of an officer who has passed through Sandhurst, his exact position being determined by the class of honours obtained in his degree. This scheme is open to schoolboys between the ages of 17½ and 19½, and to officers or men between 18½ and 20½ already doing National Service. Officers who take advantage of this scheme are required to agree to serve as Regular officers for at least five years from the date of graduation.

This is additional to the normal mode of entry, via the Royal Military Academy, Sandhurst. The effect is that, by whatever channel an officer enters the Army, he is given an opportunity of studying for a university degree in science or engineering; and even if on entry he is not in possession of all the requisite qualifications, he will find at Sandhurst an opportunity for further study to complete them.

In April, the Ministry of Supply sponsored a scheme for ten studentships for civilians, value £265 per annum plus fees, tenable for three years at the College. The holders of these studentships, which are awarded on school reports and a competitive interview, are required to read for a London External Special Degree in natural science or for the degree in engineering. The primary object of the scheme is to train young men for posts in the Government scientific service, and on graduation the student is expected to enter the competition for scientific officers and to accept a suitable post, if offered. This is the first time during its history of nearly a century that the College has opened its doors to civilians, and the large entry received for the first ten studentships showed that the prospect of life at a residential college in an attractive area of English countryside appealed to many.

O. G. Sutton

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND

ANNUAL REPORT FOR 1951–52

THE annual report for 1951–52* of the Council for the Preservation of Rural England again stresses the need for a dispassionate assessment of the country's national resources in land as a whole, but records the view of the Council that the balance needs to be redressed more in the direction of agriculture and the safeguarding and creation of amenity, on which other interests are encroaching unduly. Insufficient attention is also being paid to land reclamation in all its aspects and to the important problem of restoration after exploitation. Such forms of exploitation as open-cast coal working should, in the Council's opinion, be terminated at the earliest possible moment. The safeguarding and creation of amenity, in fact, are receiving less and less consideration, whereas they should be one of the main purposes of planning legislation; moreover, while the requirements of the Departments of State are by law outside the control of the planning authority, something other than mere consultation at departmental level is required in assessing true priorities where the relative values of land use on a national scale are concerned.

Much time is still occupied by the consideration of the land requirements of the Armed Services so as to ensure that evidence is provided on amenity and scientific grounds wherever appropriate. Settlement of the outstanding requirements is regarded as unlikely to give a total varying much from the present figure of 550,000 acres compared with the estimate of 619,000 acres of the 1947 White Paper. The report comments pointedly on the delays in announcing the results of public inquiries and on the little time allowed to the Council or the local authorities in submitting comments on the Services' proposals as compared with the extreme leisure in which the proposals are handled by government departments.

Further reference is made in this report to the question of mineral extraction, and particulars are given of some cases with which the Council has been concerned. The situation as regards electricity undertakings was described fully in last year's report and is regarded as unchanged, but the Council records its opinion that much more could and should be done to avoid disfigurement in rural areas. In regard to the administration of national parks, the Council supports the view of the National Parks Commission and endorses the Commission's stand against the schemes of the British Electricity Authority in the Snowdonia National Park. The problem of refuse disposal in rural areas has caused some difficulty, and examples of successful action by the Council are quoted.

The efforts of the Council and associated organizations succeeded in securing certain amendments to the Forestry Bill in Parliament which removed the misgivings caused by the original Bill's disregard of amenity, and the Rivers (Prevention of Pollution) Act, 1951, was likewise greatly improved during its passage through Parliament, by amendments sponsored by the Council through its representation on the Central Council for River Protection. All such achievements must, however, be considered in the light of the growing tendency to disregard amenity, which is stressed at the outset of the report, and of the precarious financial position of the Council, which requires at least four thousand additional annual subscribers of one guinea or more to provide a sufficient income for the current year.

* Council for the Preservation of Rural England. Annual Report, 1951–52. Pp. 50+4 plates. (From the Council, 4 Hobart Place, London, S.W.1, 1952.)

SECOND INTERNATIONAL CONGRESS ON RHEOLOGY

IT will be recalled that the First International Congress on Rheology was held in Scheveningen, Holland, in September 1948 (see *Nature*, **162**, 747; 1948). A Dutch Organizing Committee was responsible for the arrangements for the Congress, which was held under the auspices of the Joint Commission on Rheology, International Council of Scientific Unions. Dutch industry provided the necessary funds. It was generally agreed that the Congress was most successful.

With the approval of the Joint Commission, the British Society of Rheology is organizing a Second International Congress, to be held in Oxford during July 26–31, 1953. The headquarters of the Congress will be at St. Hilda's College; accommodation has also been reserved in other Colleges.

The programme will include an address by the president, Sir Geoffrey Taylor, and invited lectures from some half-dozen prominent rheologists. Mme. A. Dobry-Duclaux (Paris), Dr. P. Eggleton (Edin-

burgh), Prof. F. H. Müller (Marburg), and Dr. R. S. Spencer (Midland, Michigan) have already accepted invitations to lecture; Prof. E. Forslind (Stockholm) has accepted provisionally; a Dutch rheologist and perhaps one other are also being invited to lecture. There will be an open discussion on the international organization of rheology.

The Congress will cover the whole field of the study of the deformation and flow of matter, except such specialized subjects as have come to be regarded as branches of applied mechanics, such as the classical theory of elasticity and aerodynamics. Contributions to the Congress, which must not exceed 2,000 words in length (including space for figures), will be welcomed, subject to referee's approval, if received by the organizing secretary by December 1, 1952.

The Proceedings will be published in book form, and, since it is intended to circulate proofs of the papers at the Congress itself, contributions cannot be guaranteed inclusion in the Proceedings if received late. It will facilitate discussion if papers are written and delivered in English. If this is not possible, French or German may be used. Contributions cannot be accepted for publication unless one of the authors is present to read the paper personally or, in very exceptional cases, can provide a colleague from his own laboratory who is fully competent to answer questions in the discussions. Lantern slides may be shown. Speakers, other than the invited lecturers, will be strictly limited to about 15–20 min. in presenting their papers. The exact time available will depend on the number of contributions received and, if necessary, several programmes will be run simultaneously.

Invitations have been or are being sent to rheologists in all countries where it is known that rheological research is in progress. It is hoped that the Congress may provide an opportunity for an exchange of views for rheologists from all over the world. It is requested that, if any groups of rheologists have been inadvertently overlooked, they will make themselves known to the organizing secretary as soon as possible.

Arrangements will be made for excursions, visits to colleges, etc., during the Congress. The wives of rheologists are welcome. The fee for the Congress, including available preprints, and a copy of the final Proceedings, is expected to be about £4, payable before May 1, 1953. (The cost of board and lodging varies: in college, it is at present estimated at about £1 10*s.* per day, inclusive.)

Final application for membership of the Congress should be made on forms which will accompany the provisional programme. Provisional application, on forms now available from the Organizing Secretary, should be returned to him, if possible, by October 1, 1952.

The Organizing Committee consists of the following: Mr. A. G. Ward, chairman (president, British Society of Rheology); Dr. G. W. Scott Blair, honorary organizing secretary; Dr. J. G. Oldroyd, honorary treasurer; Dr. V. G. W. Harrison, honorary editor; Mr. P. Feltham (honorary secretary, British Society of Rheology, and deputy organizing secretary to the Congress); Mr. E. B. Atkinson; Mr. L. Grunberg; Dr. E. W. J. Mardles; Dr. Barbara S. Neumann; and Mr. N. Wookey. Local arrangements in Oxford are being made by Captain E. W. Geidt. Further information can be obtained from the organizing secretary, Dr. G. W. Scott Blair, University of Reading.

GEOPHYSICAL AND METEOROLOGICAL CHANGES IN THE PERIOD JANUARY–APRIL 1949

By R. P. WALDO LEWIS and D. H. McINTOSH
Meteorological Office, Edinburgh

FROM a study of the daily meteorological ionospheric and geomagnetic observations made near London during January–April 1949, Beynon and Brown[1] concluded "that quite marked 27-day recurrence tendencies may sometimes occur throughout the terrestrial atmosphere from the ground to the highest levels, and that such tendencies can be associated, directly or indirectly, with the occurrence of large sunspot groups and their accompanying radiations". The truth of this assertion is well established for ionospheric and geomagnetic phenomena, but in spite of attempts by many authors, no direct relationship between solar activity and meteorological events has yet been proved real. The conclusion of Beynon and Brown has, by implication, more than theoretical interest, since the effect on surface pressure is large enough to merit being taken into account in practical long-range weather forecasting. The period in question has therefore been examined in some detail, and the results are presented here.

The midday (G.M.T.) values of surface pressure at each of the stations New York, Horta (Azores), Reykjavik, Aldergrove (Northern Ireland), Lerwick, Kew, Bordeaux, Lisbon, Copenhagen, Strasbourg and Malta during the four solar rotations (108 days) from January 12 to April 29, 1949, were analysed by means of a 'successive difference' method to obtain the length of the most marked oscillation period of between 9 and 33 days at each place. At the first six of the above stations a main period varying between 25 and 30 days was indicated, while at the remaining five, various other periods were more marked. This illustrates a feature of meteorological data which is in contrast to that of most other branches of geophysics. Whereas, for example, conspicuous ionospheric and geomagnetic events are generally world-wide in character, even large-scale meteorological events appear to affect only relatively small parts of the earth's surface. The existence of a direct link between solar radiations and regional meteorological events seems therefore to have an inherent improbability which makes it particularly necessary for any apparent connexion to satisfy stringent statistical tests of reality.

The evidence produced by Beynon and Brown consisted mainly of a striking similarity, at times even in fine detail, of the five-day running mean curves of Kew surface pressure and of deviations from the monthly mean curve of the vertical incidence critical frequency of normal E region (Δf_0E). There was also less striking similarity between the smoothed pressure curves and those for the $F2$ region (Δf_0F2) and magnetic indices K. For reasons to be mentioned later, attention is confined here to the original unsmoothed data. The amplitude (c) and phase (φ) of the Fourier component of length of period 27 days were separately determined for the Kew pressure and Slough Δf_0E series from January 12 to April 29, 1949. Allowance was made for eighteen missing Δf_0E midday values by an interpolation process. The standard deviation (σ) was determined for each series and the amplitude ratio (a) calculated from the equation:

$$a = \frac{c}{\sigma\sqrt{2}}.$$

a is unity for a pure sine curve. The coherence of each series, as measured by the correlation coefficient between successive terms (r_1), was evaluated and the modified amplitude ratio a_1 was obtained from the formula:

$$a_1^2 = a^2 \cdot \frac{1 + r_1^2 - 2r_1 \cos q\,\alpha}{1 - r_1^2}$$

as used by Walker[2]. a_1 represents the amplitude ratio of the original series with the effects of coherence removed. The values of c, φ, σ, a, r_1, a_1 for each series are listed in the accompanying table, together with the values of the probability criterion of Schuster (P_S) and of Fisher (P_F).

	c	φ	σ	a	r_1	a_1	P_S	P_F
Pressure	5·6 mb.	224°	8·8 mb.	0·45	0·67	0·23	0·057	0·989
Δf_0E	0·08 Mc./sec.	44°	0·10 Mc./sec.	0·53	0·37	0·35	0·001	0·043

From the table, it can be seen that the 27-day waves in the respective series were exactly out of phase, which is in keeping with the inverse relationship found by Beynon and Brown. For the pressure series we find that, from a series of 108 random terms, about one period in eighteen, chosen at random from all the independent periods of a complete Fourier analysis of the observations, would have an amplitude ratio greater than 0·23 ($P_S = 0{\cdot}057$), while there is a very high probability that at least one of the periods would have such an amplitude ratio ($P_F = 0{\cdot}989$). If, therefore, the 27-day period were one selected at random from the harmonic analysis of a group of 108 pressure readings (also selected at random), it would be significant at about the 5 per cent level. However, the group of pressure readings considered was deliberately chosen because it had the peculiarity of a "sequence of four maxima in atmospheric pressure at approximately 27-day intervals", and we are considering the amplitude-ratio of this 27-day period which is the greatest in the whole set of independent amplitude-ratios occurring in the harmonic analysis of the group of pressure readings. We therefore need to consider the chance that the greatest amplitude-ratio M occurring in the harmonic analysis of 108 random numbers should exceed 0·23. From above we see that 99 times out of 100 M exceeds 0·23. The 27-day period occurring in the selected pressure groups cannot therefore be considered physically significant. For the Δf_0E series, P_S and P_F are respectively about 1 in 1,000 and 1 in 23, values which suggest that the 27-day period in this series is probably significant, especially since the period was not chosen because of any feature shown by these observations.

The correlation coefficient between the unsmoothed midday pressure values and the corresponding values of Δf_0E (90 available pairs) was found to be − 0·22. It is common practice in meteorological and geophysical papers to imply the significance of a correlation coefficient by writing it as $r \pm E$, where

$$E = 0{\cdot}67 \cdot \frac{1 - r^2}{\sqrt{n}}, \qquad (1)$$

n being the number of pairs correlated. This practice makes two assumptions which are rarely justified. First, there is the assumption that the n pairs are independent, which is never true of successive daily values in geophysics. It can be shown that the 'equivalent number of repetitions' in a series of n values is given by

$$\varepsilon(n) = 1 + 2\left(1 - \frac{1}{n}\right)r_1 + 2\left(1 - \frac{2}{n}\right)r_2 + \ldots + \frac{2}{n}r_{n-1} \qquad (2)$$

where r_1, r_2, r_3 ... denote the correlation coefficients between successive terms, terms two apart, terms three apart ... and so on. In most practical cases r_n becomes negligible after $n = 4$ or 5. Applying (2), a value of $\varepsilon(n) = 6$ was obtained for the pressure series and of $\varepsilon(n) = 2$ for the Δf_0E series. Such a large difference in the degree of coherence of the respective series is in itself strong evidence against the existence of a significant relation between them. In actual figures, the effective number of independent pairs in the correlated series can be assumed to be between 15 $\left(\text{that is, } \frac{90}{6}\right)$ and 45 $\left(\text{that is, } \frac{90}{2}\right)$. The second assumption made in the application of (1) is that r is distributed normally with standard deviation $\frac{(1 - r^2)}{\sqrt{n}}$. This is true only for $n > 500$: for smaller n, the distribution of r becomes skew[3], and for $n < 50$ the approximation is not valid. The probability that a coefficient r is derived from a population with coefficient ρ is, however, easily obtained from an approximation due to Fisher[4]. This states that $\{(\tanh^{-1} r) - (\tanh^{-1} \rho)\}$ is normally distributed about $\frac{\rho}{2(n-1)}$ with variance $\left\{\frac{1}{n-1} + \frac{4 - \rho^2}{2(n-1)^2}\right\}$. Applying this approximation in the present case, we find a probability of 0·436 that 15 pairs from an uncorrelated normal population will have a correlation coefficient $\geqslant 0{\cdot}22$; for 45 pairs the probability is 0·148. The highest of eight lag correlation coefficients evaluated (four days either side of correspondence) was only − 0·26, when Δf_0E lagged two days behind pressure. It is evident from these figures that the relationship between the two series cannot be considered significant.

The correlation coefficients were also evaluated between the unsmoothed pressure values and those of f_0F2 and K indices. Insignificant coefficients of − 0·06 and + 0·04 respectively were obtained, both from 108 pairs of values.

These results show conclusively that the apparent close relationship between surface pressure and the ionospheric and solar data over this period cannot be accepted as real. The erroneous conclusion drawn from the smoothed data illustrates the danger of attaching too much significance to such data. This is because the taking of running means introduces a high degree of artificial coherence into a series, thereby greatly reducing the number of statistically independent terms. The serial correlations r_1 to r_4 for a series of five-term running means of a random series are: $r_1 = 0{\cdot}8$, $r_2 = 0{\cdot}6$, $r_3 = 0{\cdot}4$, $r_4 = 0{\cdot}2$, and are thereafter zero. Only every fifth term may be taken as independent ($\varepsilon(n) = 5$ in equation (2), for large n). It is thus apparent that a large correlation coefficient between two smoothed series may be no more significant than a small one between the corresponding unsmoothed series. In practice, even the unsmoothed series frequently have a high degree of coherence, so that the number of independent pairs is in any case small compared with the total; the application of five-term running means reduces this number almost to zero. [March 8.

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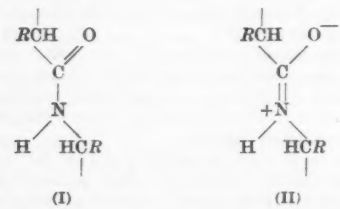
INFRA-RED DICHROISM AND PROTEIN STRUCTURE

CURRENT ideas of the configuration of polypeptide chains in proteins are based largely upon observations of X-ray diffraction patterns[1,2] and infra-red dichroisms[3,4]. While the interpretation of X-ray data is possible by well-established methods, the interpretation of infra-red dichroisms is, at present, subject to certain difficulties. Briefly, these are: (*a*) the lack of information concerning the precise nature of the atomic motions associated with certain absorption bands, and (*b*) the uncertainty in our knowledge of the directions of the transition moments associated with these absorption bands, which depends upon electronic factors as well as the atomic displacements. In the past, it has been generally assumed that the principal absorption bands observed in the infra-red spectra of proteins arise from highly localized bond-stretching or bond-deformation vibrations, so that the associated transition moment directions are along or perpendicular to the bonds according to the type of vibration involved. In view of the weight placed on observations of infra-red dichroisms in the determination of the configurations of protein chains[5], it is important that the inadequacy of these concepts should be pointed out.

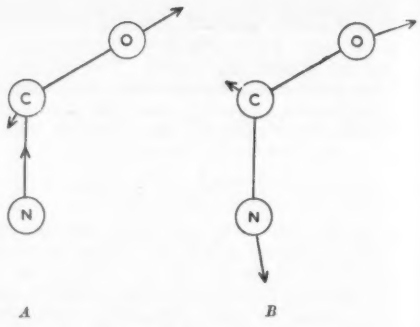
An exact mathematical treatment of the normal vibrational modes of the peptide group is impossible in the present state of knowledge, but an approximate treatment may be carried out by analogy with the well-known normal modes of simple molecules. It has been established by X-ray studies of simple peptides[6] that considerable resonance occurs between structures (I) and (II).



(I) (II)

As a result, the stretching force constant of the CN bond is greater than that of a normal C—N bond, and that of the C=O bond is correspondingly reduced. The stretching force constants of the CO and CN bonds have been calculated from the observed bond-length, using Gordy's empirical method[7]; the values are $10{\cdot}5 \times 10^5$ and $7{\cdot}8 \times 10^5$ dynes cm.$^{-1}$ respectively, so that considerable mechanical interaction will occur between these bond vibrations. The resulting modes involve motion of all three atoms simultaneously and will, in first approximation, correspond to modes *A* and *B* of a bent triatomic molecule. Mode *A* corresponds to the 'CO'-frequency observed at *c.* 1,650 cm.$^{-1}$ in the spectra of peptides and proteins. The direction of transition moment in this mode will be somewhere intermediate between the directions NC and CO. The extent of the displacement from the CO direction will depend upon the degree of mechanical interaction.

Approximate calculations indicate that the frequency of mode *B* lies fairly close to that of the NH bending vibration. Geometrical considerations show that the coupling between these vibrations is very great, and will result in the appearance of two bands; the first, corresponding to the out-of-phase mode in which there is relatively small motion of the nitrogen atom but fairly large deformation of the hydrogen atom, is identified with the so-called NH-bending frequency observed near 1,550 cm.$^{-1}$. This view is supported by the spectra of deuterated peptides in which this accidental degeneracy is removed[8]. A band appears near 1,130 cm.$^{-1}$ in the expected position for an ND-bending vibration, and a further band appears at *c.* 1,490 cm.$^{-1}$ corresponding to mode *B*. The identification of the in-phase component, confined mainly to motion of the carbon and nitrogen atoms, presents some difficulty; but it may represent the band at *c.* 1,270 cm.$^{-1}$ which is reduced in intensity, as would be expected, upon deuteration.



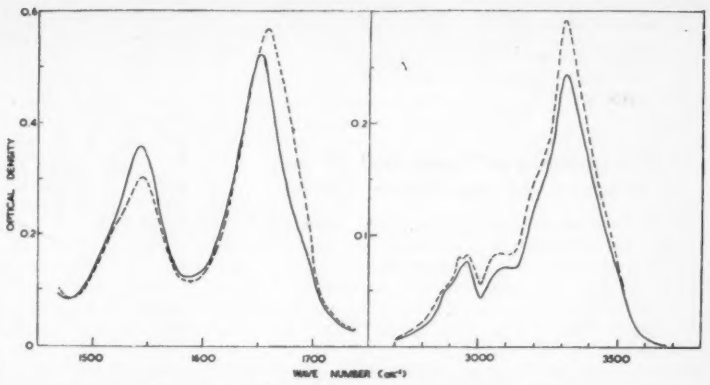
A *B*

While the argument outlined is based on an oversimplified treatment of the mechanical problem, such treatments have been applied successfully in the case of hydrocarbons[9], and should be applicable here. It is clear that the transition moment direction associated with mode *A* is not along the CO bond, but displaced towards the NC direction. This is purely a result of considering the mechanical vibration.

The second factor which influences the transition moment, and which is probably the more important one, is the orbital-following associated with the '*A*' vibration. As the CO distance increases, the proportion of the resonating structures (I) and (II) alters in favour of (II). Thus, during the vibration a varying negative charge appears on the oxygen, and a corresponding positive charge on the nitrogen atom, giving rise to a changing dipole moment in the NO direction. There is strong evidence for this effect, which results in increased intensity of the carbonyl absorption in conjugated ketones as well as in amides[10]. A similar orbital-following effect is responsible for much of the intensity of the antisymmetrical valence vibration of carbon dioxide at $4{\cdot}2\,\mu$ and accounts very satisfactorily for the sign of the bond–bond cross term[11]. A rough calculation based on extinction coefficients indicates that the transition moment of the 1,650 cm.$^{-1}$ band in the amide group is inclined at 10–15° to the CO direction as a result of this effect alone.

In order to test the conclusions arrived at, we have calculated the dichroism to be expected from an oriented polypeptide in which the chains have the configuration described by Pauling and Corey for their 3·7 residue helix[12]. The transition moment associated with the 3,300 cm.$^{-1}$ absorption band was assumed to be in the NH direction, that of the 1,650 cm.$^{-1}$ absorption being displaced by 20° from the CO direction towards NO. The figure of 20° was

arrived at by assuming a value of 15° as the displacement due to orbital following and a further 5° due to the mechanical form of the vibration. The effects of imperfect orientation were approximated to by assuming the orientation of 90 per cent of the material to be perfect and the remainder completely random. The values arrived at for the dichroic ratios of the 3,300 and 1,650 cm.$^{-1}$ bands are 15 and 4·1 respectively. These are close to the values observed experimentally by Elliott *et al.* for poly-γ-benzyl-L-glutamate in the folded configuration[12]. We consider, therefore, that these observations are in good agreement with the existence of a 3·7 residue helix, and cannot be maintained as valid objections to it[14].



Infra-red dichroism exhibited by oriented tobacco mosaic virus. Absorption with electric vector vibrating parallel to the direction of shear (full curve) and perpendicular to the direction of shear (broken curve)

One of us (R. D. B. F.) wishes to acknowledge the receipt of a Nuffield Foundation Fellowship during the tenure of which this work was carried out.

R. D. B. Fraser
W. C. Price

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Infra-Red Dichroism of Tobacco Mosaic Virus Nucleoprotein

It has been shown by Elliott and Ambrose[1,2] that the configuration (α- or β-) of a polypeptide chain may be characterized by the dichroism of the infra-red absorption bands associated with the in-plane vibrations of the amide groups. They have also noted that the transformation from the α-configuration to the β-configuration is accompanied by frequency shifts of the so-called CO-stretching and NH-bending absorption bands. From these observations it is possible, therefore, to determine both the configuration and direction of polypeptide chains in an oriented protein structure.

The infra-red dichroism exhibited by oriented tobacco mosaic virus nucleoprotein has been measured in this laboratory using a 0·8 N.A. reflecting microscope in conjunction with a Grubb–Parsons infra-red spectrometer[3]. The microscope attachment was housed in a 'Perspex' box so that the absorption bands of atmospheric water vapour were eliminated. The polarized infra-red radiation was obtained with a selenium film transmission polarizer[4] placed immediately after the exit slit of the spectrometer. Suitable specimens were obtained by smearing a concentrated gel of the nucleoprotein on a silver chloride plate, and the absorption was measured with the electric vector vibrating perpendicular and parallel to the direction of shear, that is, to the axis of the tobacco mosaic virus rod[5]. The results obtained are given in the accompanying record, in which optical density is plotted against wave number for the two directions of the electric vector.

The dichroisms exhibited by the absorption bands at 3,300, 3,065, 1,657 and 1,544 cm.$^{-1}$ are those to be expected from either β-chains parallel, or α-chains perpendicular, to the direction of shear. The frequencies of the last two bands are, however, those associated with the α-configuration.

It may be inferred, therefore, that the major component of the protein in tobacco mosaic virus exists in the α-configuration, and that the chain axes are preferentially oriented perpendicular to the axis of the rod-like tobacco mosaic virus particle. It is interesting to note that in other fibrous protein structures which have been investigated[6,7] the chain direction has been determined to be parallel to the direction of shearing.

I wish to thank Prof. J. T. Randall for his continued advice and encouragement, Dr. M. H. F. Wilkins, who suggested the problem, for helpful discussions, and Dr. G. Markham for supplying the tobacco mosaic virus. I also wish to acknowledge the receipt of a Nuffield Foundation Fellowship.

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July 14.

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LETTERS TO THE EDITORS

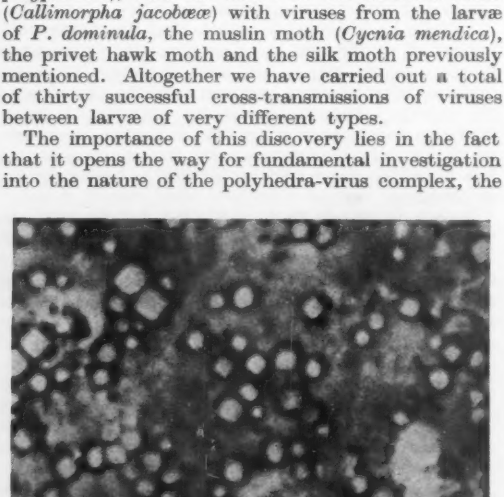
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Transmission of Polyhedral Viruses between Different Insect Species

Most workers with the polyhedral viruses affecting insects have regarded them as strictly species-specific and only transmissible to closely related species with great difficulty. Indeed, previously in such attempted cross-transmissions we have had little success although we have transmitted the polyhedral virus of the common clothes moth, *Tineola bisselliella*, to the case-bearing larva of another species of clothes moth, *T. pellionella*.

Most of the attempts to transmit polyhedral viruses from one insect species to another have been carried out between closely related or similar insects, on the assumption that transmission would be easier in these circumstances. We have, however, disregarded this assumption which, even with plant viruses, is not entirely justified, and have, instead, attempted transmission between the most distantly related lepidopterous larvæ we could find. This gave immediate success, and we have had positive transmissions to the larvæ of the small tortoiseshell butterfly (*Aglais urticæ*) and the peacock butterfly (*Vanessa io*) of no less than seven and five different viruses respectively. These include viruses from the larvæ of the currant moth (*Abraxas grossulariata*), the scarlet tiger (*Panaxia dominula*), the cream spot tiger (*Arctia villica*) and an American species of silk moth (*Telea polyphemus*). Similarly, we have infected the larvæ of the privet hawk moth (*Sphinx ligustri*) with viruses from *P. dominula*, *A. grossulariata* and the silk moth (*T. polyphemus*), and the larvæ of the cinnabar moth (*Callimorpha jacobææ*) with viruses from the larvæ of *P. dominula*, the muslin moth (*Cycnia mendica*), the privet hawk moth and the silk moth previously mentioned. Altogether we have carried out a total of thirty successful cross-transmissions of viruses between larvæ of very different types.

The importance of this discovery lies in the fact that it opens the way for fundamental investigation into the nature of the polyhedra-virus complex, the metabolic basis of polyhedroses and the relationshid between the virus and the type of polyhedral crystal formed. As regards this last point, in the experiments thus briefly outlined, we have found that in staining properties and morphology the polyhedra which develop in the new host are similar to, but not always identical with, those developing in the original host. In the accompanying illustration is shown a photograph of the polyhedral bodies produced in larvæ of the peacock butterfly by a virus of the scarlet tiger moth. Note that the rectangular shape characteristic of scarlet tiger polyhedra is still preserved. We do not think, however, that it is permissible to make a definite statement attributing the characteristics of the polyhedral crystal to either virus or host. For example, much seems to depend upon the age of the larva at the time of infection, and this in turn seems to be closely connected with yolk metabolism.



Polyhedra from a larva of the peacock butterfly produced by a virus from a larva of the scarlet tiger moth; note the rectangular shape of the polyhedra

One of us (N. X.) has carried out independent experiments on this question, investigating predictions made on the lines of a theory on the development of insects and the metabolic basis of polyhedroses. Further experimental study of this theory is in progress, and the theory and observations will be published elsewhere.

In conclusion, we would state that these experiments on the cross-transmission of viruses do not invalidate the idea that latent viruses exist in lepidopterous larvæ as previously suggested[1], though they do throw a new light on the situation.

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Variation in *Vi*-Phage II of *Salmonella typhi*

The recent description of phenotypic variation in bacteriophages by Luria[1] and Bertani[2] has prompted us to publish the results of experiments carried out in 1947 which show analogous features.

The object of the work was primarily to investigate the possibility of tracing a specific *Vi*-phage type of *Salmonella typhi* in which 'degraded' variants had arisen (see Craigie and Felix[3]). It was hoped also to gain more information about the mechanism of 'degradation' of cultures and the processes concerned in the adaptation of *Vi*-phage II of Craigie and Yen[4] to the specific *Vi*-types of *Salm. typhi*. Degradation in a specific *Vi*-type can take all forms from the appearance of minor cross-reactions with heterologous phages, typical of partly degraded strains, to the full susceptibility to all adapted phages which characterizes Type *A*.

Our experiments showed that it is not possible by the adaptation of *Vi*-phage II to a degraded variant to prepare phages bearing the specificity of the type from which the degraded variant has sprung. This was reported at the fifth International Congress for Microbiology in 1950[5].

Valuable information was obtained on the mechanism of adaptation of *Vi*-phage II to the various *Vi*-types of *Salm. typhi*, and it is this aspect of the work which is summarized here. A full account will be given by us later.

In their original description of the *Vi*-typing phages, Craigie and Yen[4], and Craigie[6] suggested that the acquisition of type specificity by the adapted typing preparations was due to the selection by the different strains of *Salm. typhi* of host-range mutants already present in any phage preparation used for adaptation. This concept was used as the working hypothesis on which they selected their different *Vi*-type strains of *Salm. typhi*.

Our work was carried out with degraded strains isolated from specific *Vi*-types of the typhoid bacillus. The strains were further subdivided by plating into single-colony lines, some of which reacted as Type *A*, while others gave the incomplete cross-reactions characteristic of 'degradation'. Table 1 shows the origin of the eight strains employed, with a description of their *Vi*-phage reactions.

Table 1

Original *Vi*-phage type of strain	No. of strains	*Vi*-phage reaction of selected 'degraded' substrains
D 5	2	Type *A*
N	3	Degraded
O	2	Type *A*
T	1	Type *A*

The following ten adapted *Vi*-typing phages were propagated on these strains: phages *C*, *D* 4, *D* 5, *D* 6, *E* 1, *F* 1, *L* 1, *N*, *O* and *T*. All phages were grown from selected single plaques.

Results. The phages grown on organisms which gave the full Type *A* reaction fell into two groups, as shown in Table 2.

Table 2

Phages changed to phage *A* on propagation	Phages propagated unchanged
C	*D* 5
E 1	*D* 6
F 1	*O*
L 1	*N*
T	

Phage *D* 4 was propagated as phage *D* 1 on Type *A*; this will be discussed later.

The change from the various adapted phages to phage *A* occurred uniformly in all the many plaques cut. The phage *A* so produced was indistinguishable from the ancestral phage *A* and again contained variant particles able to attack other types; no indication could be found that the phage had propagated as the former type, and it was concluded that the change from the former type (that is, *C*, *E* 1, *F* 1, etc.) to phage *A* had occurred in a single step commencing with the particle initiating each plaque which had been cut. This 100 per cent reversion of adapted phages to the original phage *A* suggested that, whatever was responsible for the production of adapted phages with a newly acquired host-range, the process did not involve the selection of stable host-range mutants but of particles capable of undergoing a change which, for convenience, may be described as phenotypic variation.

It is not clear from these experiments whether the initiation of plaques during the adaptation of phage *A* to heterologous types of *Salm. typhi* results from the selection either of particles possessing this susceptibility to modification, or of organisms metabolically different from the general population that are able to initiate the change in any particle. The fact that the number of plaques produced by phage *A* on a heterologous type is proportional to the concentration of phage suggests that the former hypothesis is more likely to be correct.

In contrast, the four phages which were propagated unchanged (phages *D* 5, *D* 6, *O* and *N*) behaved as stable host-range mutants; we were unable to change them to phage *A* by propagation on organisms giving the full Type *A* reaction. That a phage behaving as a host-range mutant may nevertheless show phenotypic variation is evident from the change of phage *D* 4 to phage *D* 1 on Type *A* strains. Phage *D* 4 was first produced by adapting phage *A* to Type *D* 1[4] and then adapting the resulting phage *D* 1 to Type *D* 4[7]. In this case, phage *D* 1 could be regarded as a selected host-range mutant of phage *A* and phage *D* 4 as a phenotypic variation of phage *D* 1.

It may be added that the terms 'phenotypic variation' and 'host-range mutant' are used in order to interpret the phenomena observed in a way comparable to that in current use by bacteriophage workers. It is possible that the whole process of 'adaptation' of *Vi*-phage II may be a phenotypic change, and that the 100 per cent reversion of phages *D* 5, *D* 6, *O* and *N* to phage *A* has not yet been observed because the correct organism has not been employed which can act as a 'trigger' to cause the change. More work is needed on this group of phages.

Phages grown on organisms giving the degraded reaction (see Table 1) gave results which were more difficult to interpret than those described above. In the first place, these strains were much less sensitive to the phages used than were Type *A* strains, and it was often impossible to find plaques which could be propagated. Secondly, plaques when found were extremely small and difficult to cut. Phage *T* propagated on a degraded strain descended from Type *N* yielded a phage which was able to attack Types *A*, *N* and *T* with equal ease. It would appear that a strain cannot change a specific phage to phage *A* unless it possesses the full phage sensitivity characteristic of Type *A*, and that a strain which is a partly degraded variant of one of the specific types is capable of modifying *Vi*-phage II so as to yield a phage of indeterminate specificity. Only a few phages were grown by propagating phage *T* on the degraded Type *N* substrains because of the insensitivity of the latter to phage *T*, but all these phage preparations conformed to the pattern described above. The change involved could, therefore, be provisionally regarded as fitting into the phenotypically altered group in which phage *T* has been placed.

It is apparent that the original policy[3] of using phage *A* as the parent phage for adaptation to new typhoid *Vi*-types in the preparation of the routine typing phages was a sound one, because phage *A* is highly specific for Type *A* of the organism and a new phage descended from it acquires the additional ability to attack only the new type used for adaptation. In contrast, phages descended from a host-range mutant, such as phage *D* 6, may retain in full the ability to attack Type *D* 6 and will then lyse Type *A*, Type *D* 6 and the type to which they have been newly adapted.

It is interesting to note that the phenotypic variation which can be induced in *Vi*-phage II is conditioned, in some cases at least, by the alterations produced in the typhoid bacillus by bacteriophages carried by some *Vi*-phage types of the organism[8–11]. The resistance of such types to phage *A* is clearly an exclusion phenomenon, and it seems remarkable

that the presence in the bacterial cell of one kind of phage should be responsible for inducing a specific phenotypic variation in another, apparently unrelated, bacteriophage.

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Adrenal Cortical Hormones in Human Placenta

11-Dehydro-17-hydroxycorticosterone (cortisone) and a number of other adrenal cortical hormones and their metabolites have been found in human placentas. The ethyl acetate extract of a finely minced placenta, freed from blood so far as possible, was evaporated to small volume, washed with 0·2 *M* sodium carbonate, 0·2 *N* hydrochloric acid and 0·1 *M* sodium acetate and evaporated to dryness. The residue was taken up in petroleum ether and extracted with 70 per cent aqueous ethanol. The united lower layers were evaporated to dryness, and the residue was taken up in benzene which was extracted ten times with equal volumes of water. The united aqueous layers were extracted with chloroform, and the extract dried and evaporated to dryness. The residue was examined by paper chromatography at 37° using a benzene–50 per cent methanol system[1]. Several α,β-unsaturated ketonic substances were present. That present in largest amount reduced triphenyl tetrazolium chloride, had the same R_F value as cortisone and gave a blue colour with iodine. Elution with 90 per cent ethanol was followed by evaporation to dryness and acetylation with acetic anhydride in pyridine. The resulting acetate was examined by paper chromatography at 37° using a benzene–petroleum ether (1 : 1) : 80 per cent methanol system, and was found to have the same R_F value as cortisone acetate. Rough estimation of the fluorescence in ultra-violet light after treatment with methanolic caustic soda indicated a yield of approximately 100 μgm. cortisone per placenta. Traces of 17-hydroxycorticosterone are also present, and at least three other α,β-unsaturated 3-ketosteroids which are at present unidentified.

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Changes in the Flow Birefringence of Myosin as a Result of Muscular Atrophy

Many of the changes in atrophic muscle are perhaps consequences of diminution of tension. The special importance of myosin has prompted several workers to look for changes in its physicochemical properties as a result of atrophy. Apart from a decrease in the concentration of myosin[1], and changes in its anabolism[2], there has been noticed only a greater fragility of myosin threads[1]. While a diminution of birefringence of whole muscle has been observed[3], that of pure myosin has not as yet been studied.

We have undertaken a systematic study of dilute solutions of myosin, prepared according to the technique of Mommaerts[4], from normal and atrophic rabbit gastrocnemius. The muscles were sampled ten to thirty days after unilateral section of the sciatic nerve. The intact muscle was always taken as control.

Using a technique developed by one of us[5,6], we have measured the angle of extinction from which the length of the most frequent particles present in the solution was determined. The precision of the method is about 1 per cent. From the measurement of intensity of birefringence we have determined the mean afferent anisotropy of the particles[6]. Seventeen experiments have been carried out with thirteen different rabbits. All determinations were made in 0·5 *M* potassium chloride for myosin concentrations ranging between 0·006 and 0·028 per cent and at *p*H 6·2–7·9. Concentrations have been determined by Kjeldahl's method to ± 2 per cent. The results are summarized in the accompanying table.

C per cent	*p*H	Time in days	Atrophic		Normal	
			l_f	$\bar{A}\times10^3$	l_f	$\bar{A}\times10^3$
0·012	6·7	16	2750	2·8	3050	2·4
0·006	6·2	,,	2600	6·3	2700	5·4
,,	7·1	,,	2800	6·2	2900	5·2
,,	7·2	,,	2650	6·5	2800	5·3
0·016	6·4	30	2800	2·4	2850	2·1
,,	7	,,	2750	2·6	2850	2·3
,,	7·2	,,	2700	2·6	2950	2·3
,,	7·7	,,	2750	2·6	2800	2·4
0·0076	6·5	14	2750	5·4	2800	5·3
,,	7·9	,,	2700	5·8	2750	5·2
0·015	6·5	,,	2700	2·3	2750	2
,,	7·6	,,	2800	2·1	2850	2
0·019	6·5	,,	2800	2·1	2850	2
,,	7·2	,,	2700	2·3	2800	2·1
0·028	6·6	,,	2800	1·3	2850	1·1
,,	7·7	,,	2800	1·3	3000	1·1
0·025	6·6	30	2700		3000	1·3

For all solutions, the length of the most frequent particles, l_f, is smaller for myosin extracted from atrophic muscle than for myosin from normal muscle. On the other hand, the mean anisotropy of particles, $\bar{A}$, is higher for atrophic than for normal muscle myosin. The duration of atrophy (ten to thirty days) has no detectable influence upon the results. The mean value of length of most frequent particles is 2850 A. for normal myosin at the concentrations studied.

The mean value of the ratio l_f(atrophic)/l_f(normal) is 0·94 ± 0·006; while the mean value of the ratio A(atrophic)/A(normal) is 1·1 ± 0·01. Considering the precision of the technique, these values are highly significant.

The afferent anisotropy of the particles varies markedly with protein concentration[7], so that $\bar{A}$ is approximately inversely proportional to myosin concentration. It is therefore necessary to determine the

anisotropy ratio at the same concentration. A variation of l_f with concentration can also be observed[7]; but for a large range of concentrations these variations are very small, and minor errors in concentration would have no bearing upon the results regarding length of particle.

Further work is required to explain these results. However, it may be worth while to consider the following provisional explanations:

(1) Contamination of the preparations, especially of myosin from atrophic muscle, with actin, is unlikely, since addition of adenosine triphosphate does not decrease birefringence, as would be the case if some actin were present.

(2) A modification of extractability of different myosins, as Dubuisson[8] observed after muscular contraction, is possible. Investigation of the electrophoretic properties of myosin prepared from normal and atrophic muscle is under way in an attempt to elucidate this problem.

(3) Finally, it may be that myosin of atrophic muscle is actually modified in some manner. If this proved to be true, it would represent, as Pauling has described for hæmoglobin, a "molecular disease".

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Electrical Resistance and Structure of the Hen's Egg

THE yolk and white of the hen's egg show wide differences in osmotic pressure, *p*H and ionic composition, which are maintained for a long period of time on storage. This has frequently been supposed to result from a property of the vitelline membrane which separates the two phases, although J. Needham, who has recently reviewed this subject[1], has concluded that there must be the co-operation of some physical property of the yolk and white.

As this property can only be a barrier to diffusion, and might be reflected in a low electrical conductivity, this has been measured for the various structures of the intact egg. The electrodes were of platinum wire coated with varnish except for 3 mm. at the tip, which was flattened to increase its conducting area, and blackened.

	White (Δ = −0·44° C.)	Yolk (Δ = −0·56° C.)	
		Broken-up	Intact
Conductivity (mho/cm. × 10^{-4}, 18° C.) Median	8·25	2·84	0·070
Range	6·7–9·4	2·5–3·4	<0·05–0·11
Diffusional resistance	1·3	4·85	200

One electrode was pushed up from below through the intact yolk until close below the upper surface of the vitelline membrane, and the other brought into proximity in the white lay upon it. When the membrane was ruptured between them, there was no marked change in resistance. This indicated that it was not an important barrier and would have to be isolated in order to estimate its contribution. Accordingly, the membrane was carefully washed free of yolk with homogenized white, and introduced between the closely spaced electrodes of a Kohlrausch cell under some more of the same liquid. On withdrawing the membrane, a just measurable decrease of resistance was produced—one that could have been compensated for by about a 30-μ increase in the electrode spacing.

Two wire electrodes mounted side by side, 4 mm. apart, were used to measure the conductivity of the white and yolk. Summarized in the table are the results from 24 eggs from one day to four months old; however, no marked trends with age were found. Shown also is the ratio between the median conductivity of each phase and that of an isotonic sodium chloride solution, which is a rough indication of the resistance to ionic diffusion. A stock 1 per cent sodium chloride solution served throughout as a standard of conductivity.

The conductivity of the white was not significantly different *in situ* or after separation and homogenization.

The yolk, however, showed a much lower conductivity when the electrodes were introduced into it through a small cut in the membrane than when it had been broken up by separating it in a syringe. The measured value often differed appreciably from point to point in the intact yolk, probably as a result of damage caused by the electrodes, and, though minimum values are quoted in the table, they are possibly still too high. Making allowance for this variability, the conductivity seemed to be uniform and isotropic throughout the outer $\frac{1}{2}$–1 cm. of yolk, but generally rose tenfold towards its centre.

To explain this high resistance to diffusion, there must be some internal structure in the yolk—a continuous solid phase, which can be easily broken down mechanically to yield a continuous aqueous phase. On the basis of these results, no other factor would appear to be responsible for the delay in equilibration in the intact egg.

This work was carried out while on leave from the Medical Research Council, with a scholarship from the Italian Government. I wish to thank Prof. S. Visco for the hospitality of his Institute and for introducing me to the problem.

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Division of the Flattened Egg

It has long been known that when a fertilized egg is flattened between two plates it may cease to divide. Zeuthen[1] has shown recently that although cell division is inhibited, nuclear division may continue, so that many nuclei may be present in a single flattened cell. I obtained essentially similar results during the summer of 1951, at Roscoff. It was found that, if the egg was not too greatly compressed, it would eventually divide and, once division set in, cleavage of the cytoplasm would continue until the normal ratio of one nucleus to one cell was re-established.

When the degree of flattening is too great to permit cleavage, eventually bodies of granular cytoplasm may segregate around the individual nuclei, separated from one another by gelled cytoplasm. The volumes of these segregates of granular cytoplasm are often similar to the volumes of the cells which would have existed at that stage if division had been possible. For example, at the 16-nuclei stage there are four segregates which are much smaller than any of the others, corresponding to the four micromeres of the 16-cell stage.

It was also observed that if a number of eggs were flattened by the weight of a small glass plate, the degree of flattening was not constant. Between divisions the flattening was maximal. Just before cell division the degree of flattening diminished sharply, so that the upper glass plate was raised. Then after division the degree of flattening increased. This cycle of events was repeated at each division.

The simplest explanation of the change in ease of deformation is that immediately before division there is an increase in the tension at the cell surface, and that in the plane which was occupied by the metaphase chromosomes this tension reaches a higher value than elsewhere, so that cleavage ensues in this plane. When cleavage is complete the tension falls off to its original value, only to rise again before the next cleavage.

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Fish Feeding on *Simulium* Larvæ

During investigations on the food of migrating fish in the Tanganyika region, a species of fish (*Varicorhinus tanganicæ* Boulenger) was found to feed on algæ, diatoms and insect larvæ covering stones and bottom in streams. *Simulium* larvæ proved to be the principal item of the food of *Varicorhinus*.

In 120 fish, 51 per cent were found to contain *Simulium* larvæ or pupæ, 48 per cent Ephemeroptera nymphs, 47 per cent Chironomids, 30 per cent other insects and 40 per cent plant material. In some of the stomachs the number of *Simulium* larvæ was very high, in some cases more than 50 (once 57).

The structure of the mouth in the genus *Varicorhinus*, with sharp edges in place of true lips, seems to be well adapted to scraping stones and weeds. *Varicorhinus* spends a part of its life in Lake Tanganyika, where the mineral content of the water is high, and another part in the affluent streams where the mineral content is low. It is able to ascend very rapid streams and withstand strong currents. The temperature of its home waters was found to vary between 17° and 27° C. and their electric conductivity between 49·7 and 566·2 $\times 10^{-6}$ mhos. The bottom of its home waters is often stony; but in the Lake it lives among weeds as well. *Varicorhinus tanganicæ* seems thus to be a very adaptable fish to varied external conditions.

The interest of the observations on food is that *Simulium* larvæ are sometimes very common in the rapid streams of East and Central Africa, and may give rise to swarms of very disagreeable flies, some species of which carry diseases of man and cattle. *Varicorhinus tanganicæ*, or perhaps other species of the genus from rivers, could probably be introduced in regions where blackflies constitute a pest, as in the Nile near the Ripon Falls in Uganda.

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Discovery of *Tetragonurus* Risso, 1810, in South African Waters

The rare oceanic form *Tetragonurus cuvieri* Risso, 1810, has been known with some certainty since the sixteenth century from an account by Rondelet. It has at intervals been reported, mainly as single specimens, from the following localities: Mediterranean (sixteenth century onwards); Madeira (1839); Australia (1882 onwards); North Atlantic (1895); Hawaii (1928); California (1936 onwards); Japan (1939); New Zealand (1948). This fish has therefore been found over a wide range of temperate seas, but not hitherto in the Indian Ocean or in the adjacent Western Pacific.

A specimen of *Tetragonurus* has recently been found on the south coast of Natal, at about 31° S. This is noteworthy as the first record from the Indian Ocean. In addition, its characters and the locality have an important bearing on the question of whether all the specimens so far discovered are all one rather polymorphous species, or whether more than one exists.

A detailed description and figures of this fish will be published later.

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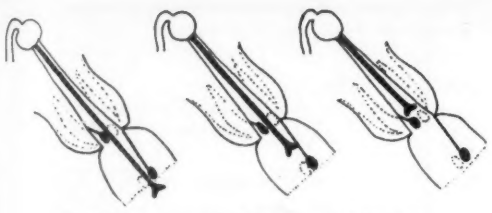
Trimorphism and Self-incompatibility in *Narcissus*

In 1887[1] and 1888[2] the Portuguese botanist Henriques described trimorphic heterostyly in two forms of *Narcissus* which he called *N. triandrus* L. and *N. reflexus* Brot., both belonging to *N. triandrus, sensu lato*. Though detailed studies have been made of trimorphic heterostyly in *Lythrum*[3] and *Oxalis*[4] the only subsequent investigation of this phenomenon in *Narcissus* seems to be a recent one by Fernandes[5], who published the frequencies of the three style-lengths in natural populations and speculated on the



Long-style Mid-style Short-style

The three flower forms of *Narcissus triandrus*

genetic determination. The frequencies were 1 long (*L*) : 4 mid (*M*) : 1 short (*S*) in *N. triandrus* and 1 : 2 : 1 in *N. reflexus*.

In 1950, Dr. Fernandes kindly sent me from Portugal collections from two populations of *N. triandrus* var. *concolor*. Fifteen plants have flowered this spring. From this small amount of material it is already possible to draw several conclusions.

1. Like most other *Narcissus* species, homomorphic and heteromorphic, *N. triandrus* is self-incompatible, setting no seed or a few shrivelled seeds on selfing.

2. All plants can be classed as long-styled, mid-styled or short-styled.

3. The anthers are at the same two levels in all the individuals so far observed. This contrasts with *Lythrum* and *Oxalis* in which there are three levels in the flower in each form, occupied by stigma or anthers, so that as the stigma alters in height so must the anthers move also.

In *N. triandrus* the three stigma levels are : above the upper tier of anthers ; between the two tiers ; and below the lower tier (see accompanying figure).

4. Though self-pollination is consistently sterile, cross-pollination between plants of the same style-length is just as fertile as that between plants with different style lengths (see table).

L selfed 0	*L* × *L* 0	*L* × *M* 74
0	45	54
0	48	
M selfed 0	*M* × *M* 71	*L* × *S* 21
		0
S selfed 0	*S* × *S* 9	*M* × *S* 72
2	27	
(shrunken)		*S* × *M* 38
Total ripe seeds from 6 capsules 0	200	259

Seed set per capsule in *N. triandrus* pollinations. Long, mid and short-styled forms are represented by *L*, *M* and *S*

Thus the three flower forms do *not* correspond to three inter-fertile intra-sterile mating groups as in *Lythrum* and *Oxalis*. There is some indication of cross-incompatibility, but since each cross is represented by a single capsule this would have to be confirmed.

It is probable, then, that the self-incompatibility of *N. triandrus* and also of the rest of the genus is due to a multipolar incompatibility system, the polymorphism for style-length being an independent phenomenon of problematical value to the species.

It may be doubted whether this polymorphism can truly be regarded as trimorphism, for in the small number of plants examined the style-length within any one of the three groups has been very variable. It is possible, therefore, that we are dealing with continuous variation. If this were so, it would be expected that the mean length (mid-style) would also be the mode (that is, the most frequent), as Fernandes found in natural populations. The idea of 'trimorphism' probably arose from the fact that with the two distinct anther heights as markers any variation in style length falls naturally into three classes : below the lower tier, between the two tiers and above the upper tier.

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Permeability of Isolated Rat Heart Sarcosomes

The study of the permeability of mitochondria, to which the sarcosomes of cardiac muscle are closely related, has depended on indirect, mostly biochemical, methods[1,2]. One of the difficulties in any other approach has been the relatively great (and obviously abnormal) permeability of isolated mitochondria or sarcosomes to most ions at room temperature, which results in swelling and other morphological changes. With the discovery that Ca^{++} ions are intimately related to this abnormal permeability of sarcosomes and that the calcium-chelating agent versene, by removing calcium from the granules, greatly increases their stability at room temperature[3], the problem of sarcosome permeability has become more accessible to attack by other methods.

Two methods, previously used in studies of red cell permeability, suggested themselves for such a study : (*i*) determination of the rate of onset of the morphological changes in different suspending media (analogous to the hæmolysis method in red cells),

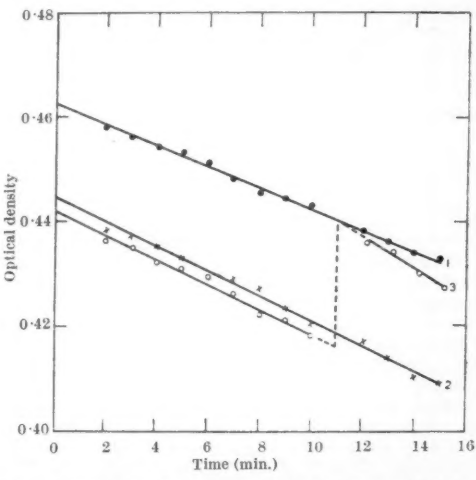

Fig. 1. Measurement of swelling in hypotonic medium and of rate of permeability of solute : curve 1, sarcosome suspension diluted with 0·165 *M* potassium chloride in Beckman cell at zero time ; curve 2, the same, except that 0·125 *M* potassium chloride was used : curve 3, as curve 2, except that at 11 min. sufficient potassium chloride was added to bring final concentration to 0·165 *M*

and (ii) study of the rate of change of the light-scattering properties of sarcosome suspensions. Some observations made with the latter method are here described. The method consists of studying the rate of change in optical density of sarcosome suspensions in 1-cm. cells in the Beckman spectrophotometer at 520 mμ.

When a suspension of sarcosomes in isotonic buffered saline containing versene (0·115 *M* potassium chloride, 0·02 *M* phosphate, 0·01 *M* versene, *p*H 7·4) is diluted in a Beckman cell with isotonic saline (0·165 *M*), the optical density slowly decreases with time, as shown in curve 1 of Fig. 1. The optical density at zero time is obtained by the extrapolation shown. If the sarcosomes are diluted with hypotonic saline (0·125 *M*), there is an immediate rapid fall of the optical density (see curve 2), complete before the first reading is taken, followed by the same slow decline shown in curve 1. By extrapolating curve 2 to zero time, an optical density corresponding to 0·125 *M* potassium chloride is obtained. In this way the curves relating optical density to the concentration of potassium chloride, shown in Fig. 2, were obtained.

Both the rapid decrease of optical density and the slow decline are due to swelling of the sarcosomes, which results in less light scatter, presumably because of a decrease of refractive index of the sarcosome on swelling. The rapid change is due to movement of water in response to the hypotonic conditions; the slow decrease is due to permeability to solute and affords a quantitative measure of the permeability. In this communication, the permeability is expressed as the reciprocal of the time (in minutes) required for a change of 5 per cent in the initial optical density (0·3–0·5) of the suspension.

After short time exposures to hypotonic conditions, the original density is regained when isotonicity is restored, although in most experiments there was evidence that the hypotonic swelling had caused an increased permeability to the solute. A typical experiment is shown in curve 3 of Fig. 1.

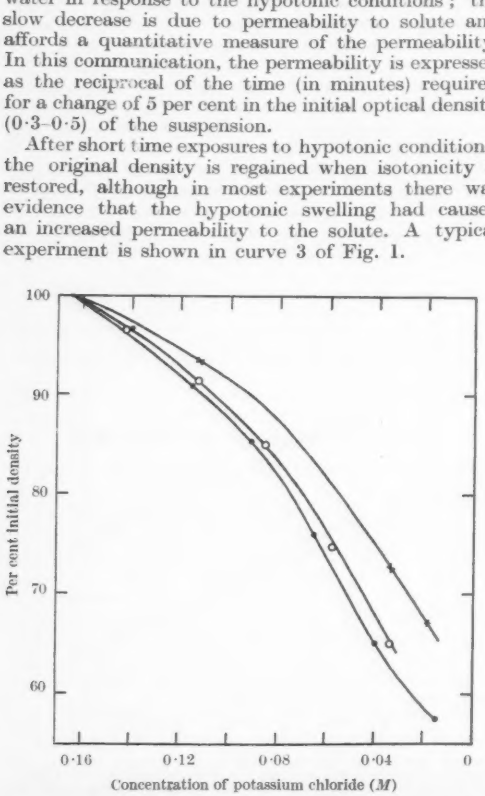

Fig. 2. Relation between initial optical density and tonicity of suspending medium (potassium chloride). The optical density is expressed as a percentage of that found in 0·165 *M* potassium chloride. The curves are for three different sarcosome preparations

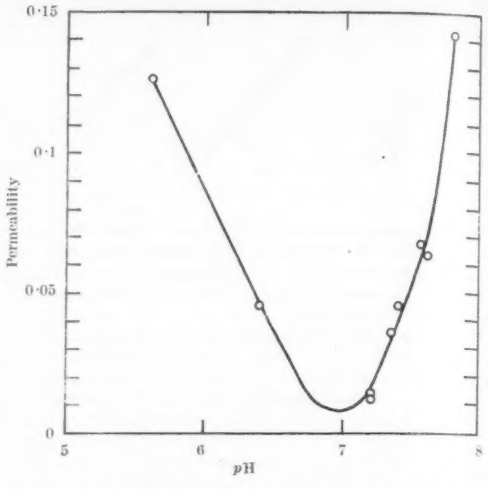

Fig. 3. Effect of *p*H on permeability to potassium chloride

Some typical permeabilities, determined on the same sample of sarcosomes, are: potassium chloride, 0·02; sodium chloride, 0·013; glucose, 0·024; and sucrose, 0·006. The initial density in isotonic solutions of these four solutes was the same. Glycerol and ethylene glycol exerted no appreciable osmotic effect (permeability greater than 10). The permeability to potassium succinate, fumarate and malate is of the same order as the permeability to potassium chloride.

The permeability to potassium chloride has varied considerably in different experiments (range 0·1–0·01). Slight differences of *p*H may have contributed to this variability, since *p*H has a very pronounced effect on permeability, as shown in Fig. 3. Another source of variability may be the level of endogenous adenosinetriphosphate in the sarcosomes. Added adenosinetriphosphate (0·0025 *M*), which greatly diminishes the permeability to potassium chloride of sarcosomes untreated with versene, also decreases the permeability of those treated with versene. This effect of adenosinetriphosphate is not only, or even mainly, due to a change in the swelling properties of the granules, since hypotonic swelling is not greatly affected by its addition.

The curves for swelling in Sørensen phosphate buffer are different from those of other substances in that there is a rapid initial swelling, complete before readings can be made, and thus resembling the swelling in hypotonic media, followed by a slower penetration ultimately resulting in the same degree of swelling as in distilled water. This suggests that only one molecular species of the phosphate buffer acts osmotically, while the other rapidly penetrates the sarcosomes. The degree of the initial swelling suggests that it is the disodium hydrogen phosphate component which is rapidly penetrating. In agreement with this explanation, it was found that, when phosphate buffer calculated to be isotonic in respect of potassium dihydrogen phosphate (0·825 *M* Sørensen buffer, *p*H 7·4) was used as suspending medium, the initial density was the same as that found in isotonic potassium chloride.

This work will be continued and will be published in full elsewhere. It was done during tenure of a

maintenance grant from the Agricultural Research Council, while on leave from the Department of Histology and Embryology, University of Sydney.

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Inhibition of Gastric Secretion of Hydrochloric Acid *in vivo* by Carbonic Anhydrase Inhibition

This preliminary communication on the inhibition of acid secretion *in vivo* in dogs by one of a new group of potent carbonic anhydrase inhibitors is prompted by the recent report of Davies and Edelman[1], which has appeared since our work was completed. These workers have shown that several other known carbonic anhydrase inhibitors, which include prontosil, *p*-toluenesulphonamide, *p*-sulphonamidobenzoate and thiophene-2-sulphonamide, can suppress the *in vitro* acid secretion of the isolated frog and toad gastric mucosa, although sulphanilamide was without effect.

We employed the hetero-cyclic sulphonamide 2-acetylamino-1,3,4-thiadiazole-5-sulphonamide, which is 440 times as potent as sulphanilamide for the 100 per cent inhibition of carbonic anhydrase *in vitro*[2]. The single intravenous injection of this material in doses of 20–60 mgm./kilo inhibited 79–97 per cent (mean, 89 per cent) of the output of hydrochloric acid from Heidenhain pouches in three unanæsthetized dogs, stimulated by the subcutaneous injection of 0·025 mgm. of histamine base every 10 min. This inhibition, which occurred after a latent period of 20–80 min., persisted for at least 3–6 hr., and the secretory function appeared to be completely recovered in 24 hr.

It has been predicted by previous workers that any degree of carbonic anhydrase inhibition sufficient to interrupt the process of acid secretion by the parietal cell must lead to the speedy death of the animal by virtue of interference with carbon dioxide transport by the blood, yet no toxic reactions were observed in this dose-range.

When the dosage was extended to 120 mgm./kilo, one of these dogs expired in respiratory arrest, while the two other pouch dogs as well as two unoperated dogs tolerated this dose well. There was no increase in the degree of acid inhibition at this dose-level.

The details of these experiments will be published elsewhere.

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Nature of Reticulin

The main obstacle to the characterization of reticulin has always been its close association with collagen. As a preliminary to an attempt to establish the nature of reticulin fibres, a histological survey of all likely tissues was carried out, and it was found that the mid-cortical connective tissues of the kidneys of children free from renal disease consist almost entirely of reticulin. The only collagen present in this situation occurs in the immediate neighbourhood of the larger blood vessels.

Reticulin was identified histologically as fine branching fibres which appear black when appropriately treated with any of the modifications of the Maresch–Bielschowasky silver-impregnation technique; take up the acid aniline dye in the Mallory connective tissue stain; show little or no fuchsinophilia in sections stained with van Gieson's picro-fuchsin; and appear red when subjected to the McManus periodic acid–Schiff's reagent procedure.

Collagen was identified in histological preparations as bundles of non-branching fibres which assume a yellow-brown colour in untoned Maresch–Bielschowasky type preparations; take up the acid aniline dye of Mallory's connective tissue stain; show well-marked fuchsinophilia when stained with van Gieson's picro-fuchsin; and give a negative reaction to the periodic acid–Schiff's reagent test.

By a process of careful dissection, followed by maceration of frozen sections of unfixed tissue in decinormal sodium hydroxide, reticulin was isolated and prepared for electron microscopy and X-ray diffraction study. Histological control was exercised throughout to ensure that the specimens consisted only of histologically acceptable reticulin and contained no collagen.

Other samples of reticulin, known to be contaminated with collagen to a greater or lesser extent, were prepared in the same way from human liver, lung, adrenal, spleen, lymph-nodes and myocardium for purposes of comparison. Reticulin has also been suggested as one of the components of the organic matter of teeth, and the present investigations indicate that it is probably present in dentine.

Reticulin from all sources produced essentially similar appearances. In electron micrographs of unshadowed specimens it appeared as very thin laminated membranes made up of a network of minute randomly arranged fibrils embedded in an apparently structureless membrane, the relative proportions of fibre and matrix varying in different specimens, even in material obtained from the same source.

In specimens shadowed with uranium the fibrils show a striated structure, the period of the striations being of the order of 650 A. Occasional bundles of fibrils were seen which were sufficiently large to be visible in an optical microscope. These bundles were only seen in material from specimens known to contain collagen. No bundles of fibrils which would be visible with an optical microscope were found in the specimens from renal cortex. In specimens in which aggregation of the fibrils into bundles had occurred, the fibril diameters were usually 400–500 A. In other specimens fibrils as small as 100 A. in width were sometimes encountered. The supporting membranes appeared to vary in thickness. Areas photographed were usually in the range 50–150 A. The illustrations (Figs. 1 and 2) are of an adrenal specimen (× 30,000). Electron micrographs of specimens which had been boiled in water and then shadowed showed that

Fig. 1

boiling effects solution of the fibrils but not the underlying matrix. The fibrils differ from ordinary collagen in that no gel results on cooling concentrated solutions.

Preliminary chemical investigations of the apparently structureless matrix in which the fibrils lie suggest that it is a glucoprotein. It is remarkably stable to boiling water; even twenty-four hours boiling does not cause it to dissolve, but merely reduces it to a finely granular precipitate.

X-ray diffraction photographs of specimens which have been boiled to remove the fibrils show a characteristic and as yet unidentified pattern. Samples of dried unboiled reticulin produce photographs which appear to be a mixture of the diffraction patterns of this material and unoriented collagen, with the collagen pattern usually predominating.

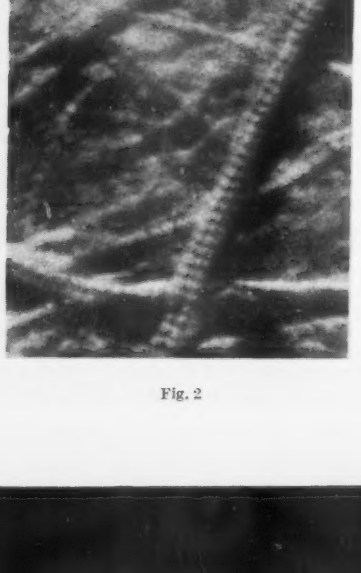

Fig. 2

Preliminary studies thus indicate that reticulin, wherever it occurs, has a membranous structure. It consists of minute randomly oriented collagen-type fibrils embedded in a structureless matrix, which is probably a glucoprotein. In connective tissues there is a continuous series of structures from this appearance to the familiar collagen picture, the transition from reticulin to collagen involving orientation of the fibrils and their aggregation into bundles, and at the same time a decrease in the proportion of the structureless matrix.

Thanks are due to Dr. J. Thewlis and Dr. A. H. T. Robb-Smith for encouragement, to the latter for permission to use post-mortem material, and to the Director of the Atomic Energy Research Establishment for permission to publish this communication.

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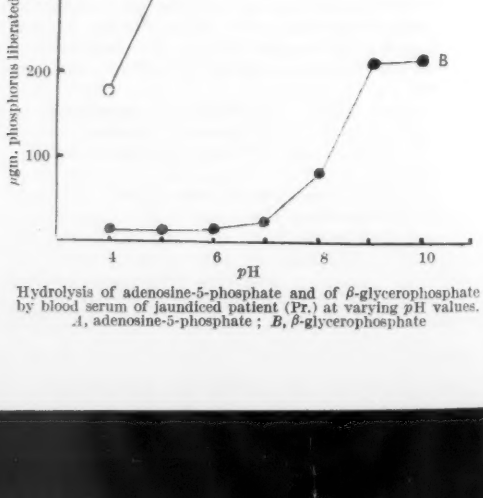
Serum 5-Nucleotidase

Reis[1-4] has demonstrated the presence of a phosphatase in various tissues specifically hydrolysing 5-nucleotides, for example, adenosine-5-phosphate. One of us has previously reported[5] that normal blood serum has a low 5-nucleotidase activity corresponding to about 1/10 of its non-specific alkaline phosphatase activity towards glycerophosphate. In bone diseases where serum alkaline phosphatase is raised, serum 5-nucleotidase may be normal; but in jaundice, either infective or obstructive, both enzyme levels may be increased, those of the 5-nucleotidase sometimes exceeding those of the non-specific alkaline phosphatase.

The serum *p*H activity curves from a particular case of jaundice, having high 5-nucleotidase activity, are shown here with adenosine-5-phosphate and β-glycerophosphate as substrates, both at concentrations of $M/400$ in barbitone buffer solution. The hydrolysis of the adenosine-5-phosphate represents the sum of the 5-nucleotidase and non-specific phosphatase actions. These curves give further con-



Hydrolysis of adenosine-5-phosphate and of β-glycerophosphate by blood serum of jaundiced patient (Pr.) at varying *p*H values. *A*, adenosine-5-phosphate; *B*, β-glycerophosphate

firmation of the definite occurrence of this specific 5-nucleotidase with an optimum at about *p*H 7·5 in some sera.

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Identification of Uric Acid and Ascorbic Acid by Chromatography

P. L. Kirk and E. L. Duggan[1] have described the identification of various substances of clinical and biological importance, and we have published a quantitative micromethod for determination of urea[2]. In this communication we report on a colour reaction for uric acid and ascorbic acid in paper chromatography. It may be noted that F. Weygand[3] and Z. Prochazka and S. Koristek[4] have described the identification of ascorbic acid with, respectively, silver nitrate and dichloroindophenol.

Our method is based on the property of uric acid and ascorbic acid of reducing ferric iron to ferrous. With *o*-phenanthrolin hydrochloric acid the ferrous ion gives a very sensitive red colour. The samples were applied to paper strips (Schleicher and Schüll, paper No. 2043 *b*) and developed by the ascending method in butanol/water/glacial acetic acid. After drying, these strips were quickly immersed in a solution of 5 ml. of ferriammonium sulphate (1·5 gm./l.) and 45 ml. of *o*-phenanthrolin hydrochloric acid (20 gm./l.), and were then dried at 80–100° C.

The following R_F values were obtained: uric acid, 0·18; ascorbic acid, 0·40. It is possible to identify 0·5 μgm. of uric acid.

The uric acid shows the red colour reaction at the usual place in the chromatogram of blood serum and urine. In the position of the ascorbic acid spot of pure solutions the urine chromatogram shows regularly a second red zone which we could not identify for certain as ascorbic acid.

The red-coloured substances were eluted from the paper strip with methanol, and measurement with a Beckman spectrophotometer (model *DU*) gave an absorption maximum of 510 mμ. On measuring the optical density of the eluate from the zone of the spot against the eluate of the same height from a strip to which no substance was applied, a relation between concentration and optical density was obtained which was of the same type as a saturation curve.

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Gaseous Contamination of Geiger–Müller Counters

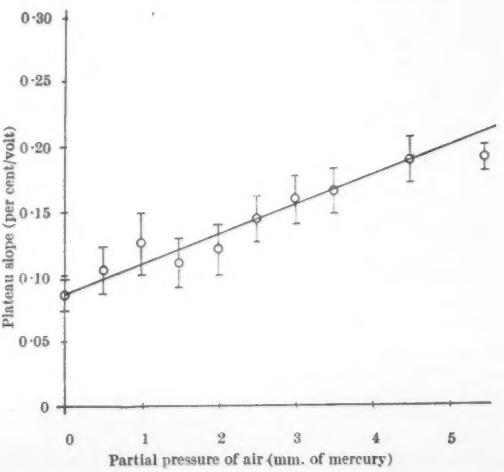
Although it is well known that the characteristics of Geiger counters may be very strongly affected by the presence of contaminated gases in the counter filling, very little quantitative work has, apparently, been published on the subject. In an experiment on extensive air showers in cosmic radiation, in which large metal-cased counters were to be used, it was desirable to know the quantities of gaseous contaminants which could be tolerated in the filling. The papers of Spatz[1], and of Korff and Present[2], include some quantitative data which were not, however, directly applicable in this case. Tests were therefore made of the effects of air and carbon monoxide as contaminants in ordinary glass-cased counters.

Standard Cintel cosmic ray counters were used, 50 cm. long and 4 cm. in diameter, with tungsten anodes and copper cathodes. The filling used was 10 cm. pressure of argon with 2 cm. of ethyl alcohol. Plateaux were plotted with a scaler, using the total flux of cosmic radiation at sea-level as a source. Counting-rates on the plateaux were approximately 520 counts/min. Operating potentials were in the range 1,200-1,400 volts. A stabilized power-pack was used.

In agreement with the work of Fenton and Fuller[3], plateau characteristics could not be reproduced exactly on successive fillings of a given counter. It was therefore necessary to add small quantities of the contaminant gases cumulatively to the same filling. This was done by means of a small gas-lock in the system, which could be evacuated separately from the counter, then filled at any desired pressure with the contaminant gas, and opened into the counter.

On first filling a counter, it was found necessary to leave it for about twenty-four hours before it had settled sufficiently for a plateau to be plotted. After adding contaminant from the lock, the system was also left for some hours so that equilibrium could be reached.

Both the length and slope of the plateau were affected by gaseous contaminants. The length of plateau is not, here, a good guide to the characteristic of the counter, since the slope increases with pressure of contaminant, and the criterion for the plateau



becomes less stringent. A better measure of the characteristic is the slope of the plateau, and this is plotted against pressure of contaminant, for air, in the accompanying graph. The effect is approximately linear for small pressures of contaminant, but appears to reach saturation at about 1 cm. pressure of air. This presumably occurs when all the argon ions moving away from the anode undergo exchange of charge with oxygen or nitrogen atoms. The plateaux were originally about 120 volts long, disappearing completely when the partial pressure of air was about 1 cm. No permanent contamination effects were observed, a plateau comparable, though not identical, with the original, being observed on re-filling.

The effect of carbon monoxide was also observed, since this is a likely contaminant in counters the cases of which are made of cast metal. The effects on the length and slope of the plateau were remarkable, a pressure of 0·5 mm. of carbon monoxide being approximately equivalent to 6·0 mm. of air. The plateau disappeared completely at a pressure of 1·0 mm. of carbon monoxide.

The deterioration of methane-filled counters has been attributed by Farmer and Brown[4] to the deposition of heavy hydrocarbons on the electrodes. It is possible that this effect is enhanced in argon-alcohol counters by the formation of carbon monoxide in the gas.

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Effect of Variation in Diameter on the Torsional Vibration of Bars

During measurements of the resonant frequencies of torsional vibrations in cylindrical bars, it was observed that variation in the diameter of the bar along its axis caused the resonant frequencies to depart from a harmonic series. In order to relate the resonant frequencies to the shape of the bar, we have adapted a method described by P. M. Morse[1] for calculating the modes of vibrating strings in which the tension varies from point to point along the length.

The method consists in expressing the displacement of the bar at any instant as the sum of a series of normal modes for a uniform bar, and regarding the departure from uniformity as a small perturbation function imposed on the mean bar diameter. Substituting in the wave equation for a non-uniform bar :

$$\frac{\partial}{\partial x}\left(a^4 \frac{\partial \theta}{\partial x}\right) = \frac{a^4}{v_0^2} \frac{\partial^2 \theta}{\partial t^2},$$

where a is the bar diameter, x the distance along the axis, θ the angular displacement and v_0 the velocity of shear-waves in the material, and dropping out second and higher order terms, we obtain an approximate equation from which the coefficients of the series representing the bar displacement and also the modification to the resonant frequencies can be determined by a process analogous to Fourier analysis.

The result obtained in this way shows that, if the departure of the bar from uniformity is expressed as

$$a = a_0\left[1 + \sum_{p=1}^{\infty} K_p \cos 2\pi px/l + \sum_{p=1}^{\infty} C_p \sin 2\pi px/l\right],$$

then the fractional change in the frequency of the mth harmonic is $-2K_m$. It will be observed that to the order of accuracy of this analysis the frequencies are unaffected by the sine components of the series. Thus, for example, a bar having a uniform taper along its length will have the same torsional resonant frequencies as a uniform cylindrical bar.

In order to verify this result, we measured the resonant frequencies on a bar of aluminium approximately 4 in. long by $\frac{1}{2}$ in. diameter, the diameter being reduced abruptly between points $l/4$ and $3l/4$ distant from one end, where l is the length of the bar, to a value 4 per cent less than that at the ends of the bar. The coefficients of the series representing the radius of the bar are then given by :

$$K_p = (-1)^{(p-1)/2}\ 0{\cdot}16/\pi p \text{ for } p \text{ odd}$$
$$= 0 \text{ for } p \text{ even.}$$

Table 1 shows the observed and calculated values of percentage frequency deviation from the mean value.

Table 1

Harmonic No.	Observed frequency deviation (per cent)	Calculated frequency deviation (per cent)
1	−5·1	−5·1
2	0·0	0·0
3	+1·8	+1·7
4	0·0	0·0
5	−1·0	−1·0
6	0·0	0·0
7	+0·80	+0·73
8	0·0	0·0

A similar analysis of the effect on longitudinal waves predicts half the above deviations, since a enters the wave equation to the second power instead of to the fourth as in torsional vibration ; but such an analysis ignores the effect of lateral inertia, which modifies the vibrations by an increasing amount as the ratio of bar diameter to wave-length (λ) increases[2-4]. Measurements confirm this divergence between simple theory and practice, as Table 2 shows.

Table 2

Harmonic No.	$\frac{2a}{\lambda}$	Observed frequency deviation (per cent)	Calculated frequency deviation (per cent)
1	0·061	−2·6	−2·6
2	0·123	0·0	0·0
3	0·184	+0·9	+0·9
4	0·245	+0·1	0·0
5	0·307	−0·4	−0·5
6	0·368	0·0	0·0
7	0·429	+0·2	+0·4
8	0·491	0·0	0·0

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Failure of Vacuum Insulation at Low Field Strengths

PRE-BREAKDOWN currents in vacuum-insulated systems are usually regarded as due to field emission. If the electrodes are not subjected to heat treatment, however, these currents occur at unexpectedly low field strengths. We have recently examined a form of conduction at 10–150 kV. D.C. across gaps of a few centimetres in continuously evacuated systems. The current is in this case distinct from field emission because (i) it is critically dependent on anode conditions, and (ii) the voltage required is only slightly changed by large variations in gap-length. Other characteristics of interest are that the current is self-extinguishing, after a charge of the order of micro-coulombs has crossed the gap, with only slight drop in voltage; and that the voltage required may be increased by factors up to 2 by increasing the pressure of residual gas in the system.

The mechanism of the conduction is still being investigated; but it is clear that there is a resemblance to the 'electron loading' experienced in accelerating tubes in the megavolt field. It is hoped to publish a detailed report shortly.

We wish to thank the Director of the Atomic Energy Research Establishment, Harwell, and the Ministry of Supply for supporting the work and for permission to publish the results.

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Definition of Chromatography

THE belief that the word 'chromatography' was coined by Tswett[1] about 1906 is incorrect; it appears to have been widely used, though with a different connotation, for more than a century and a half previously. As so often happens, Tswett appears merely to have adopted an existing word and given it an additional meaning. Paradoxically, many modern works of reference define chromatography in every way but the one which would first spring to the mind of a chemist.

In 1731, Bailey[2] defined chromatography as a treatise on colour; in 1835, Field published a book entitled "Chromatography"[3]. As recently as 1949, Funk and Wagnall[4] defined chromatography in the same sense and used 'chromatograph' to denote an instrument employed to produce different colours by rotation of a parti-coloured disk. In 1860, Holmes used 'chromatograph' as a verb meaning to represent in colour[3].

Tswett probably derived 'chromatography', and the allied 'chromatographic' and 'chromatogram', through the word 'chromatology' used by Sorby[5], with whose work on the differential partition of pigments he was certainly familiar, as he quotes it. Zechmeister and Cholnoky[6] later characterized Tswett's principal separation process exclusively as 'chromatographic adsorption analysis', but, as Koshtoyants and Kalmykov[7] have recently pointed out, Tswett recognized the possibility of applying his technique more widely than by merely forming coloured zones in simple adsorption columns.

So many processes are now by common consent accepted as forms of chromatography that an unequivocal definition of the word in its present chemical sense presents difficulties. We have proposed the following. "By chromatography is meant those processes which allow the resolution of mixtures by effecting separation of some or all of their components in concentration-zones on or in phases different from those in which they are originally present, irrespective of the nature of the force or forces causing the substances to move from one phase to another"[8,9]. This definition embraces not only the various forms of chromatography hitherto achieved but also all forms which have been postulated as theoretical possibilities.

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HERBERT WEIL
17 Provost Road, London, N.W.3.

[1] Tswett, M. S., *Ber. Deut. Bot. Ges.*, **24**, 316 (1906); *ibid.*, 384; "Works of the Warsaw Society of Natural Sciences", **14**, Biol. Sec., Min. 6 (1903).
[2] Bailey, N., "Universal Etymological English Dictionary", 2nd ed. (1731).
[3] "A New English Dictionary on Historical Principles", **2** 394 (Edited by Murray, J. S. H., 1893).
[4] "New 'Standard' Dictionary of the English Language" (Funk and Wagnall, New York and London, 1949).
[5] Sorby, H. C., *Proc. Roy. Soc.*, **21**, 442 (1873).
[6] Zechmeister, L., and Cholnoky, L., "Principles and Practice of Chromatography" (English translation) (1941).
[7] Koshtoyants, K. S., and Kalmykov, K. F., *Biochemistry* (Acad. Sci., U.S.S.R.), **16**, Min. No. 5 (1951).
[8] Weil, H., and Williams, T. I., *Naturwiss.* (in the press).
[9] Williams, T. I., and Weil, H., *Arkiv. för Kemi, Mineralogi och Geologie* (in the press).

Zoological Nomenclature

As from January 23, 1953, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified in brackets against each entry. Full particulars of these cases were published on July 23, 1952, in the *Bulletin of Zoological Nomenclature*, those relating to cases (1) to (4) in Part 8 and those relating to cases (5) to (10) in Part 9 of Vol. 6. (1) *Ancylus* Müller, 1774 (Cl. Gastropoda) (designation of type species); (2) *atrox* Baird and Girard, 1853, *Crotalus* (Cl. Reptilia, Ord. Squamata) (validation); (3) *polysticta* Cope, 1865, *Caudisona* (Cl. Reptilia, Ord. Squamata) (validation); (4) *Palæopsylla* Wagner, 1903 (Cl. Insecta, Ord. Siphonaptera) (designation of type species); (5) *Heterandria* Agassiz, 1853 (Cl. Osteichthyes) (designation of type species); (6) *Lobacantha* Kirby, 1837 (Cl. Insecta, Ord. Coleoptera) (suppression, to validate *Platypria* Guérin, 1840); (7) *tereticauda* Eschscholtz, 1833, *Triton* (Cl. Amphibia) (suppression, to validate *lugubris* Hallowell, 1849, *Salamandra*); (8) *Euryrhynchus* Miers, 1877 (Cl. Crustacea, Ord. Decapoda) (validation); (9) *Pontonia* Latreille, 1829 (Cl. Crustacea, Ord. Decapoda) (designation of type species); (10) Martyn, 1784, *Universal Conchologist* (Ph. Mollusca) (validation of following trivial names published in: *arabicum*; *canaliculus*; *crenata*; *denticulata*; *granosus*; *haustrum*; *heliotropum*; *iris*; *linea*; *maculosum*; *opalus*; *papulosum*; *punctulatus*; *purpurata*; *smaragdus*; *sulcatus*; *tigris*; *vermis*).

Comments on the above cases should be sent to me as soon as possible.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, September 22

INSTITUTION OF MINING AND METALLURGY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. A. M. Gaudin: "Radioactivity in Mineral Dressing" (Third Sir Julius Wernher Memorial Lecture).

Monday, September 22—Thursday, September 25

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall and King's College, Newcastle-upon-Tyne).—Centenary Meeting.

Tuesday, September 23—Thursday, September 25

INSTITUTION OF MINING AND METALLURGY (at the Imperial College of Science and Technology, Prince Consort Road, London, S.W.7).—Symposium on "Mineral Dressing".

Wednesday, September 24

TEXTILE INSTITUTE (at the Lesser Free Trade Hall, Peter Street, Manchester), at 9.30 a.m.—Conference on "Factors in Plant Development".

INSTITUTE OF RURAL LIFE AT HOME AND OVERSEAS (at the National Society for Religious Education, 69 Great Peter Street, London, S.W.1), at 5.30 p.m.—Mrs. G. M. Culwick: "Social Development in the Gezira".

Wednesday, September 24—Friday, September 26

NATIONAL SMOKE ABATEMENT SOCIETY (at the South Parade Pier Portsmouth).—Nineteenth Annual Conference.

Thursday, September 25

EAST MALLING RESEARCH STATION (at the Laboratories, East Malling), at 3 p.m.—Prof. H. B. Tukey: "Research Developments in Fruit Culture in America" (Amos Memorial Lecture).*

Thursday, September 25—Saturday, September 27

INSTITUTE OF BIOLOGY (at the Royal Institution, Albemarle Street, London, W.1).—Symposium on "The Biology and Productivity of Hot and Cold Deserts".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PHYSICIST (with an honours degree in physics)—The Secretary, London Hospital, Whitechapel, London, E.1 (September 27).

CHEMIST (with a degree in chemistry, and preferably some textile experience) for research on problems related to the dyeing and finishing of knitted products—The Secretary, Hosiery and Allied Trades Research Association, Thorneywood House, 4 First Avenue, Sherwood Rise, Nottingham (September 27).

EXPERIMENTAL OFFICERS in Ministry of Supply research and development establishments (most posts concern guided weapons, and require knowledge and experience of electronics)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.233/52A (September 27).

ASSISTANT IN VETERINARY PHYSIOLOGY, an ASSISTANT IN THE DEPARTMENT OF ANIMAL HUSBANDRY, and an ASSISTANT IN BIOCHEMISTRY—The Assistant Secretary of University Court, The University, Glasgow (September 30).

PROFESSOR OF ETHICS AND POLITICS, a PROFESSOR OF ELECTRICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Secretary and Bursar, University College, Dublin (September 30).

ASSISTANT SCIENCE LIBRARIAN (with a degree in a biological subject; library qualifications and special library or other bibliographical experience desirable) at London headquarters—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1 (October 1).

EXPERIMENTAL OFFICER IN THE MECHANICAL ENGINEERING RESEARCH LABORATORY (D.S.I.R.), East Kilbride, Glasgow, for research work on plastic deformation of metals occurring in commercial processes, for example, rolling, drawing and forging—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.153/52A (October 4).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF NUCLEAR PHYSICS, Australian National University—The Administrative Officer in the U.K., Australian National University, 37 Russell Square, London, W.C.1 (October 10).

LECTURER IN ELECTRICAL ENGINEERING (preferably with experience in electronics or communications engineering)—The Registrar, The University, Sheffield (October 11).

CHAIR OF GEOGRAPHY at Victoria University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

UNIVERSITY RESEARCH FELLOWSHIP IN INDUSTRIAL METALLURGY—The Secretary, The University, Birmingham 3 (October 31).

RESEARCH CHAIR OF WOOL TEXTILE ENGINEERING—The Registrar, The University, Leeds 2 (November 10).

EXPERIMENTAL OFFICER IN RADIO DEPARTMENT, Royal Aircraft Establishment, Farnborough, for experimental design of aircraft aerials for modern high-speed aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.352/52A.

LECTURER IN ZOOLOGY—The Secretary, Royal Technical College, Glasgow.

PRINCIPAL OF THE MID-ESSEX TECHNICAL COLLEGE, Chelmsford—The Chief Education Officer, County Offices, Chelmsford.

PRINCIPAL OF THE NORTH-EAST ESSEX TECHNICAL COLLEGE, Colchester—The Chief Education Officer, County Offices, Chelmsford.

RESEARCH ASSISTANT for physico-organic researches IN THE CHEMISTRY DEPARTMENT—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. A.27.

SENIOR PHYSICISTS AND CHEMISTS (and new honours graduates in these subjects)—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

TEACHER (Grade B) IN BOTANY, to take classes up to final degree standard, and a TEACHER (Grade B) IN CHEMISTRY, for work mainly up to intermediate standard—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 770 : 1952, Methods for the Chemical Analysis of Cheese. Revised edition. Pp. 12. 2*s*. net. British Standard 1865 : 1952, Air Rings (Hand-made) for Hospital Use. Pp. 8. 1*s*. net. (London: British Standards Institution, 1952.) [126

Scotland, the Wealthy Nation: a Scientist's Survey of Scots Resources. By Dr. Archie Lamont. Pp. 144. (Glasgow: Scottish Secretariat, Ltd., 1952.) 1*s*. 6*d*. [126

Council for the Preservation of Rural England. Annual Report, 1951–52. Pp. 52+4 plates. (London: Council for the Preservation of Rural England, 1952.) [126

Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory read at the Annual Visitation of the Royal Observatory, 1952 June 7. Pp. 30. (London: Royal Observatory, Greenwich, 1952.) [166

Ministry of Fuel and Power. 29th Annual Report on Safety in Mines Research, 1950. Pp. 48+4 plates. (London: H.M. Stationery Office, 1952.) 2*s*. net. [176

Catalogue of Types and Figured Specimens in the Geological Department of the Manchester Museum. By Dr. J. Wilfrid Jackson. (Manchester Museum Publication No. 6.) Pp. vii+170. (Manchester: Manchester Museum, and Manchester University Press, 1952.) 10*s*. 6*d*. net. [176

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1950–1951. Pp. 159. (London: Empire Cotton Growing Corporation, 1952.) 3*s*. [176

World Power Conference. Annual Report, 1951. Pp. 22. (London: World Power Conference, 1952.) 1*s*. 6*d*. [176

British Trust for Ornithology. Eighteenth Annual Report, 1951. Pp. 40. (Oxford: British Trust for Ornithology, 1952.) 1*s*. 6*d*. [176

Proceedings of the University of Durham Philosophical Society. Vol. 11, No. 4: Reactions between some Non-ferrous Metals and their Sulphides. By Dr. J. A. Smythe. Pp. 40–67+10 plates. (Durham: University of Durham, 1951.) [176

Proceedings of the Royal Society of Edinburgh, Section A (Mathematical and Physical Sciences). Vol. 63, Part 3, No. 18: The Elementary Proof of the Prime Number Theorem. By E. M. Wright. Pp. 257–267. 2*s*. Vol. 63, Part 3, No. 19: A Generalization of the Classical Random-Walk Problem, and a Simple Model of Brownian Motion Based Thereon. By Dr. G. Klein. Pp. 268–279. 2*s*. Vol. 63, Part 3, No. 20: On the Estimation of Variance and Covariance. By E. H. Lloyd. Pp. 280–289. 1*s*. 6*d*. Vol. 63, Part 3, No. 21: The Statistical Theory of Stiff Chains. By Dr. H. E. Daniels. Pp. 290–311. 3*s*. 6*d*. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) [176

The Xylonite Group, 1877–1952. Pp. 40. (London: B X Plastics, Ltd., South Chingford, 1952.) [176

Dental Practitioners' Formulary, 1952 for use in the National Health Service. Pp. 28. (London: British Medical Association, and the Pharmaceutical Press, 1952.) 1*s*. 6*d*.; interleaved, 3*s*. [186

Strength Tests on Driven Large Diameter Aluminium Rivets. By J. C. Bailey and A. W. Brace. (Research Report No. 13.) Pp. 60. (London: Aluminium Development Association, 1952.) 7*s*. 6*d*. [186

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain, Vol. 4: Fluorspar. Fourth edition. By Dr. K. C. Dunham; with contributions by H. G. Dines, T. H. Whitehead, Dr. J. R. Earp, J. V. Stephens, C. O. Harvey and H. E. Wilson. Pp. vii+144+4 plates. (London: H.M. Stationery Office, 1952.) 17*s*. 6*d*. net. [196

Catalogues

Thermometers. Pp. 36. (Pontypridd: H. J. Elliott, Ltd., 1952.)

Periodica in the fields of Exact and Applied Science and Technology. (Catalogue 7, Part 1.) Pp. 36. (London: Lange, Maxwell and Springer, Ltd., 1952.)

A List of 35 mm. and 16 mm. Documentary and Instructional Films. Pp. 32. (London: Petroleum Films Bureau, 1952.)

A Catalogue of Chemistry Books and Scientific Periodicals. Pp. 16. (Liverpool: A. E. Parry and Co., 1952.)

Photocells for Industrial Applications. Pp. 16. Valves and Tubes for Industry and Communications. Pp. 32. (London: Mullard, Ltd., 1952.)